

Bothalia

'N TYDSKRIF VIR PLANTKUNDIGE NAVORSING
A JOURNAL OF BOTANICAL RESEARCH

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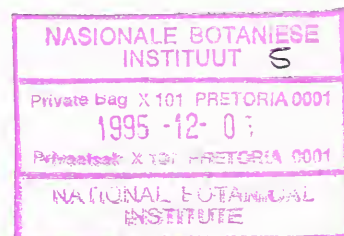
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Volume 25,2

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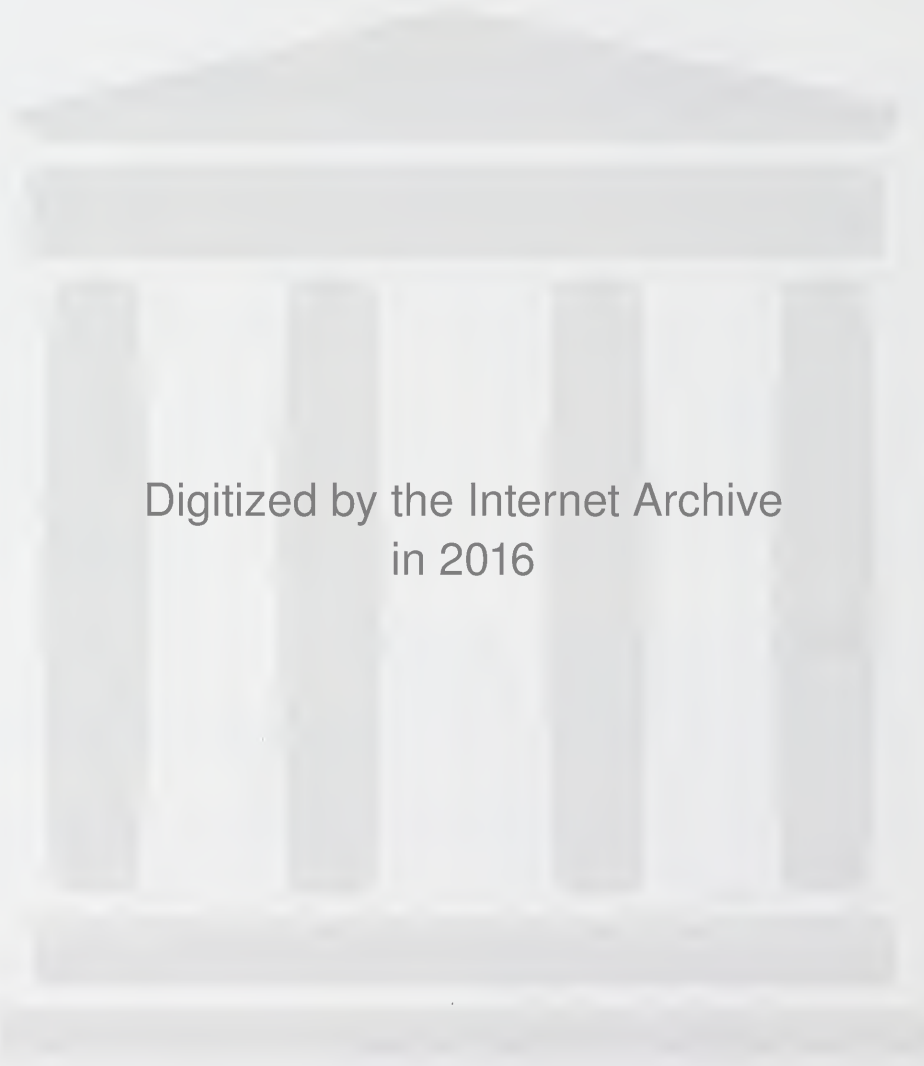
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Three subspecies of *Pelargonium laevigatum* (Geraniaceae)

C.M. VAN WYK* (née SCHONKEN) and J.J.A. VAN DER WALT**

Keywords: Geraniaceae, *Pelargonium laevigatum*, subspecies, taxonomy

ABSTRACT

Pelargonium laevigatum (L. f.) Willd. is a variable species. The macromorphology, anatomy of the leaves, chromosome numbers and geographical distribution of the species were studied, and it is concluded that three subspecies should be distinguished. The subsp. **diversifolium** (Wendl.) Schonken stat. nov. and subsp. **oxyphyllum** (DC.) Schonken stat. nov. were originally described as species. A key to identify the three subspecies, a distribution map, and illustrations of the macromorphological characters as well as anatomical features of the leaves, are provided.

UITTREKSEL

Pelargonium laevigatum (L. f.) Willd. is 'n variërende spesie. Die makromorfologie, anatomie van die blare, chromosoomgetalle en geografiese verspreiding van die spesie is bestudeer en daar is tot die gevolgtrekking gekom dat drie subspecies onderskei moet word. Die subsp. **diversifolium** (Wendl.) Schonken stat. nov. en subsp. **oxyphyllum** (DC.) Schonken stat. nov. is oorspronklik as spesies beskryf. 'n Sleutel om die drie subspecies te identifiseer, 'n verspreidingskaart, en illustrasies van die makromorfologiese kenmerke sowel as anatomiese kenmerke van die blare, word voorsien.

INTRODUCTION

Harvey (1860) described the section *Glaucophyllum* and recognized *Pelargonium laevigatum* (L. f.) Willd. as one of the species in the section. Van der Walt *et al.* (1990) altered the composition of the section *Glaucophyllum* but concluded that *P. laevigatum* should remain in the section.

P. laevigatum is a variable species and Schonken (1980) suggested that three subspecies should be distinguished. For this study the macromorphology, leaf anatomy, chromosome numbers and geographical distribution of the species have been studied to determine whether it is justified to recognize infraspecific taxa.

MATERIAL AND METHODS

For the morphological and geographical distribution studies, specimens of altogether 17 herbaria were studied. This was followed by extensive field work on different populations in the entire distribution area, mainly to determine the variation in morphological features.

Transverse sections, 12–15 µm thick, of wax-embedded terminal leaflets and petioles were cut with a rotary microtome and stained with Alcian Green-Safranin (Joel 1983). The sections were made through the middle part of the terminal leaflets and petioles.

Specimens examined for leaf anatomy and chromosome numbers

1. Subsp. *laevigatum*: Maggs 16, Willowmore 3502+; Van der Walt 734, 2n = 22, Swartberg Pass, Oudtshoorn 1444+; Van der Walt 1594,

Rooiberg Pass, Calitzdorp 4093+; 2n = 22, Schonken 150, Swartberg Pass 2014+.

2. Subsp. *diversifolium*: Van der Walt 1592, Tweedside, Matjiesfontein 4051+; Van der Walt 1063, 2n = 22; Gydouw, Ceres 4132+.

3. Subsp. *oxyphyllum*: Van der Walt 1604, 2n = 22, Cedarberg 4133+; Stirton 6401, Wupperthal 1085+.

For mitosis, root tips were treated with 0.002 mol 8-hydroxyquinoline for 24 h at 20°C, fixed in 3:1 absolute ethanol and glacial acid, and stained with aceto-carmine.

RESULTS

***Pelargonium laevigatum* (L. f.) Willd.**, Species plantarum 3,1: 685 (1800); Knuth: 436 (1912). Type: 'Cap. Bonae Spei', Thunberg s.n. (UPS 15620, lecto!., here designated).

Erect and compact or prostrate and lax subshrub, much branched, evergreen, 0.3–0.5 (–1m) high and 0.3–0.5 m in diameter. *Stems* smooth, herbaceous, glabrous or glabrescent, grey or glaucous. *Leaves* unifoliate to trifoliate, articulated to petiole, subsucculent, glabrous or pilose to hirsute, with sparse glandular hairs, glaucous; pinnae sessile, lanceolate to terete, bases cuneate, apices acute, margins entire or irregularly dentate to incised with linear segments, pinnae (10–)20–40(–70) × 1–10 mm; petiole (4–)15–20(–40) mm long; stipules free, subulate, 3–11 × 0.2–1.0 mm, somewhat succulent, glabrous to pilose. *Inflorescence*: flowers borne singly or in reduced pseudo-umbels of 2–5 flowers each, peduncle (6–)30–50 (–100) mm long, glabrous to pilose. *Pedicel* 0.5–13 mm long, glabrous or with glandular hairs. *Hypanthium* 4–38 mm long, glabrous or with glandular hairs. *Sepals* 5, narrowly ovate, adaxially concave, apices acute, glabrous or pilose to hirsute, green to reddish brown with hyaline margins, 6–12 × 1.5–3.5 mm. *Petals* 5, white or cream-coloured or pink; posterior 2 spatulate with apices obtuse

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+ project locality no.

or rounded or retuse, 11–30 × 4–9 mm, reflexed at $\pm 90^\circ$ from the middle, with reddish purple markings at base; anterior 3 spatulate to narrowly obovate with apices obtuse or rounded or retuse, somewhat smaller (11–20 × 3–6 mm) and somewhat lighter in colour than posterior petals, gradually recurved so that apices are at an angle of $\pm 90^\circ$ with bases, with fine purplish lines near bases. *Stamens*: fertile 7 (4 long, 1 medium, 2 short), staminodes 3, filaments basally fused forming a staminal column 2–3 mm long; pollen yellow to orange. *Ovary* ovate, 5-lobed, pilose; style glabrous or sparsely pilose basally, 1–4 mm long; stigmas 5, purplish, 1–2 mm long. *Mericarps*: 20–30 mm long; bases 3.5–6.0 mm long, tails 16–24 mm long. $2n = 22$.

Key to subspecies

- 1a Leaves trifoliolate, pinnae incised, southern Cape to E Cape 1. subsp. *laevigatum*
- 1b Leaves unifoliolate or trifoliolate, pinnae not incised, SW Cape to southern Cape:
 - 2a Leaves, glabrous, trifoliolate, flowers usually borne singly, restricted to Cedarberg Mountains 3. subsp. *oxyphyllum*
 - 2b Leaves hirsute, unifoliolate to trifoliolate, usually more than 1 flower per pseudo-umbel, Western Cape 2. subsp. *diversifolium*

1. subsp. *laevigatum*

Pelargonium laevigatum (L. f.) Willd., Species plantarum 3,1: 685 (1800); Pers.: 233 (1806); DC.: 667 (1824); Drège: 122 (1843); Harv.: 297 (1860); Compton: 295 (1931); Clifford: 218 (1970); Van der Walt & Vorster: 87 (1981). Type: as for *P. laevigatum* (L. f.) Willd.

Geranium laevigatum L. f.: 306 (1781); L.: 619 (1784); Cav.: 255 (1787); Thunb.: 115 (1794); Thunb.: 522 (1823). *Eumorpha laevigata* (L. f.) Eckl. & Zeyh.: 78 (1834–1837).

G. acuminatum Thunb.: 526 (1823). *Pelargonium acuminatum* (Thunb.) DC.: 680 (1824); R. Knuth: 542 (1912). Type: locality and collector unknown, specimen *UPS 15555* with Thunberg's handwriting (lecto!, here designated).

P. laevigatum (L. f.) Willd. var. *compositum* L'Hér. ex DC.: 667 (1824). Type: locality and collector unknown, specimen *G-DC 667-190* with De Candolle's handwriting (holo!).

P. macowanii Bolus: 157 (1890). Type: Cape Province, Boschberg near Somerset East, *MacOwan 1647* (BOL., holo!; GRA, K!, SAM!, Z!).

Diagnostic morphological features

Leaves trifoliolate, pinnae variously incised, glabrous to sparsely hirsute, flattened, 1–5 flowers per pseudo-umbel (Figure 1).

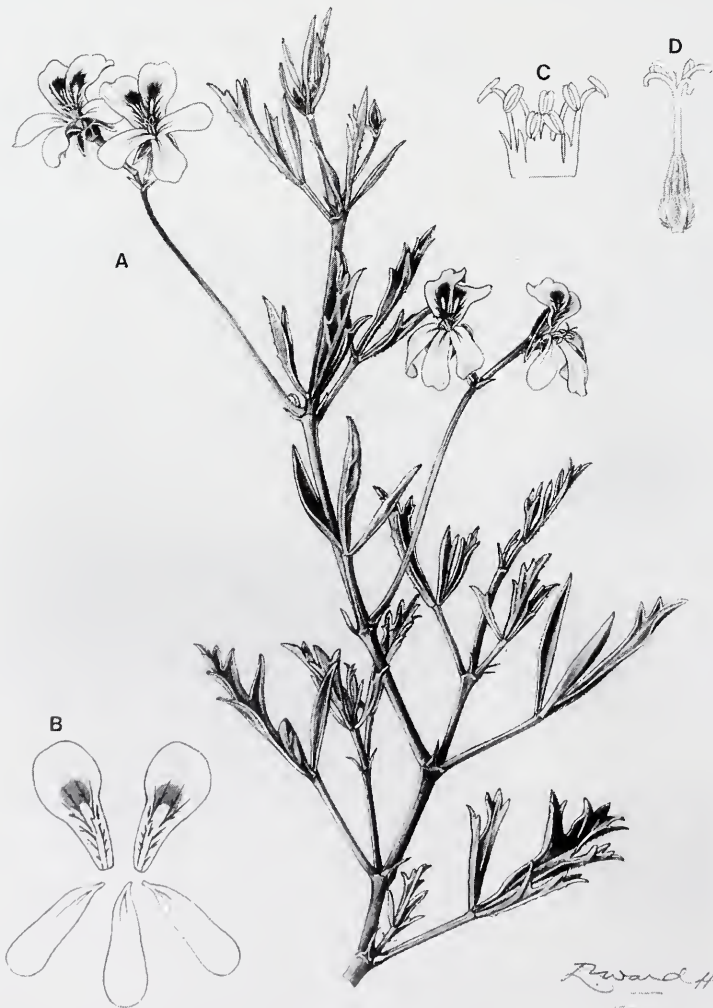


FIGURE 1.—*P. laevigatum* subsp. *laevigatum*, Ward-Hilhorst 185. A, flowering branch, $\times 0.7$; B, petals, $\times 1$; C, androecium, $\times 2$; D, gynoecium, $\times 2$.

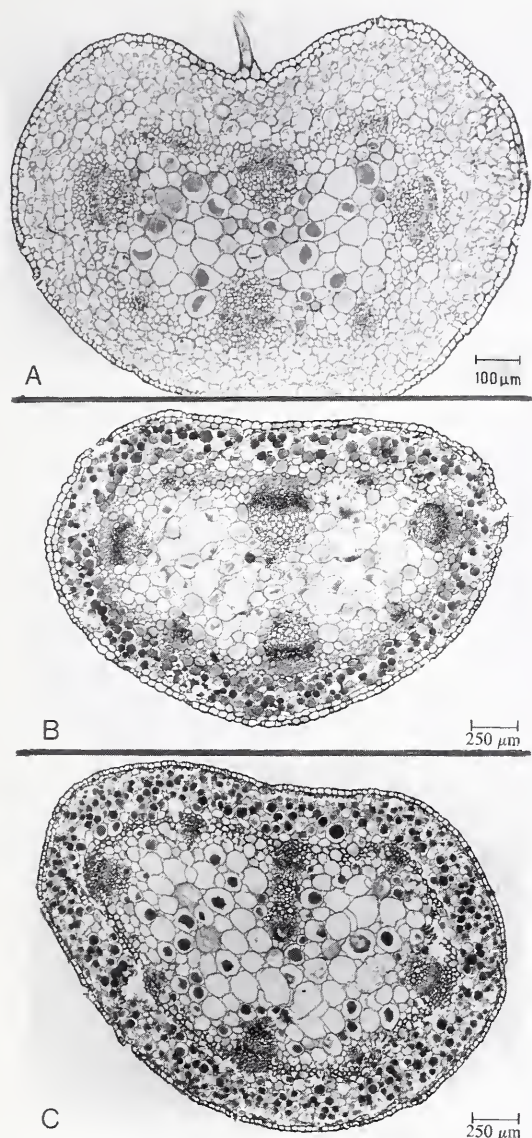


FIGURE 2.—Transverse section of petiole of *P. laevigatum*. A, subsp. *laevigatum*, Mags 16; B, subsp. *diversifolium*, Van der Walt 1603; C, subsp. *oxyphyllum*, Van der Walt 1604.

Diagnostic anatomical features of leaves

Petiole: cordiform in transverse section, glandular hairs multicellular, non-glandular hairs unicellular, hypodermis not clearly differentiated, parenchymatous cortex 4–6 layers, extraxylary sclerenchyma cylinder continuous and 2–4 layers wide, main vascular bundles 4, smaller bundles 2–6, medullary bundle usually lacking (Figure 2A). **Lamina:** V-shaped to more or less flattened in transverse section, trichomes as on petiole, stomata evenly distributed in ad- and abaxial epidermis, mesophyll not clearly differentiated in palisade and spongy parenchyma, 2 adaxial palisade layers larger than 1 abaxial layer (Figure 3A).

Specimens examined

EASTERN CAPE.—3225 (Somerset East); Boschberg, (–DC), *Macowan* 1479 (SAM), 1647 (BOL, GRA, K, MEL, SAM, Z), 3323 (Willowmore); Slypsteenberg, (–AC), *Esterhuysen* 6278 (BOL); near Willowmore, (–AD), *Mags* 16 (STEU); Buispoort, (–AD), *Theron* 1011 (PRE); Baviaanskloof, (–BC), *Van Wyk* 384 (STE); 37 km E of Willowmore, (–DA), *Olivier* 1643 (STEU); between Miskraal and Smitskraal, (–DA), *Hugo* 1451 (STE); Studtis, (–DB), *Manson* 53, 67 (STE); 15 km W of Joubertina, (–DC), *Van der Walt* 856 (STEU); Joubertina, (–DD), *Esterhuysen* s.n. (BOL), *Fourcade* 3217 (BOL), *Horn* s.n. (PRE); near Joubertina, (–DD), *Esterhuysen* 7040, 22797 (BOL), 3324 (Steytlerville); Langkloof, (–AB), *Ecklon & Zeyher* 609 (SAM); Kouga Hills, (–CA), *Esterhuysen* 6661 (BOL, PRE); Kouga Mountains, (–CA), *Bayliss* 6382 (MO, NBG, WAG); Kouga, (–CA), *Compton* 10525 (BOL, NBG); between Cambria and Smitskraal, (–CB), *Oliver* 4551 (STE); Kareedouw, (–CD), *Compton* 4516 (BOL); Mordenaarskloof, (–CD), *Stayner* s.n. (NBG); Baviaanskloof, (–DA), *Bayliss* 4423 (MO); NW of Cambria, Baviaanskloof, (–DA), *Oliver* 4535 (PRE, STE), 3325 (Port Elizabeth); Otterford Forest Reserve, (–CC), *Oliver* 4443 (PRE), *Rodin* 1109 (BOL, MO, PRE), 3424 (Humansdorp); Krommerivier Heights, (–BA), *Fourcade* 2704 (BOL, PRE, STE).

WESTERN CAPE.—3321 (Ladismith); Rooiberg, (–DA), *Compton* 3917 (BOL, NBG), *Esterhuysen* 17144 (BOL), *Oliver* 5330 (PRE, STE), *Schonken* 150 (STEU), *Taylor* 9796 (STE), *Van der Walt* 1594 (STEU); Gamka Mountain Reserve, (–DB), *Boshoff* 360 (STE), 3322 (Oudts-hoorn); Baviaanskloof, (–AC), *Bayliss* 4423 (NBG), *Boucher* 38 (STEU), *Gill* 19 (BOL, PRE); Swartberg Pass, (–AC), *Bolus* 11739 (BOL, PRE), *Compton* 10419 (NBG), *Hafström & Acocks* 753 (BOL, PRE), *Moffett* 696 (STEU), *Pocock* 120 (PRE), *Schonken* 150, 189, 190 (STEU), *Stokoe* s.n. (SAM), *Thompson* 2195 (PRE, STE), *Van der Walt* 734, 1148, 1589 (STEU); Kamanassie Mountains, (–DA/DB), *Zinn* s.n. (SAM), 3323 (Willowmore); 13 km W of Uniondale, (–CA), *Wells* 2835 (GRA, PRE); Bo-Koega, (–CB), *Bayliss* 7081 (MO); Kouga Mountains, (–CB), *Wisura* 2173 (NBG); Prince Alfred Pass, (–CC), *Fourcade* 2091 (BOL).

Subsp. *laevigatum* occurs in the southern and eastern Cape, and it is known from Rooiberg near Calitzdorp, eastwards to Otterford Forest Reserve near Port Elizabeth (Figure 4). It has been collected from 180 m above sea level near Humansdorp to 1 600 m in the Swartberg Range. The rainfall in its distribution area varies from 200–600 mm per annum.

Subsp. *laevigatum* is morphologically very variable but a continuous variation pattern makes it impossible to divide it into different taxa. Varying characters are the number of flowers per pseudo-umbel and the size of the petals, as well as the indumentum and degree of incision of the leaf margins. To complicate matters, there seem to be natural hybrids between subsp. *laevigatum* and *Pelargonium fruticosum* (Cav.) Willd. *P. laevigatum* depicted in Van der Walt & Vorster (1981) with greenish leaves is most probably an example of such a hybrid. These suspected hybrids occur in the Swartberg Pass where subsp. *laevigatum* and *P. fruticosum* are common.

The plants occurring at Boschberg near Somerset East have finely divided leaves superficially resembling those of *P. fruticosum*. This form was described by Bolus (1890) as *P. macowanii* and quoted by Knuth (1912) as *P. divaricatum* (Thunb.) DC. var. *scabrum* Harv. However, the glaucous leaves and floral characters of these plants are typical of *P. laevigatum* and we concluded that they represent a form of subsp. *laevigatum*. The atypical leaves are probably the result of the local environmental conditions and geographical isolation.

Some plants growing in Long Kloof (*Fourcade* 2704) and in the Otterford Forest Reserve (*Wilman* 1109) have up to five flowers per pseudo-umbel and the petals are exceptionally large. The pinnae of these plants are also relatively wide.

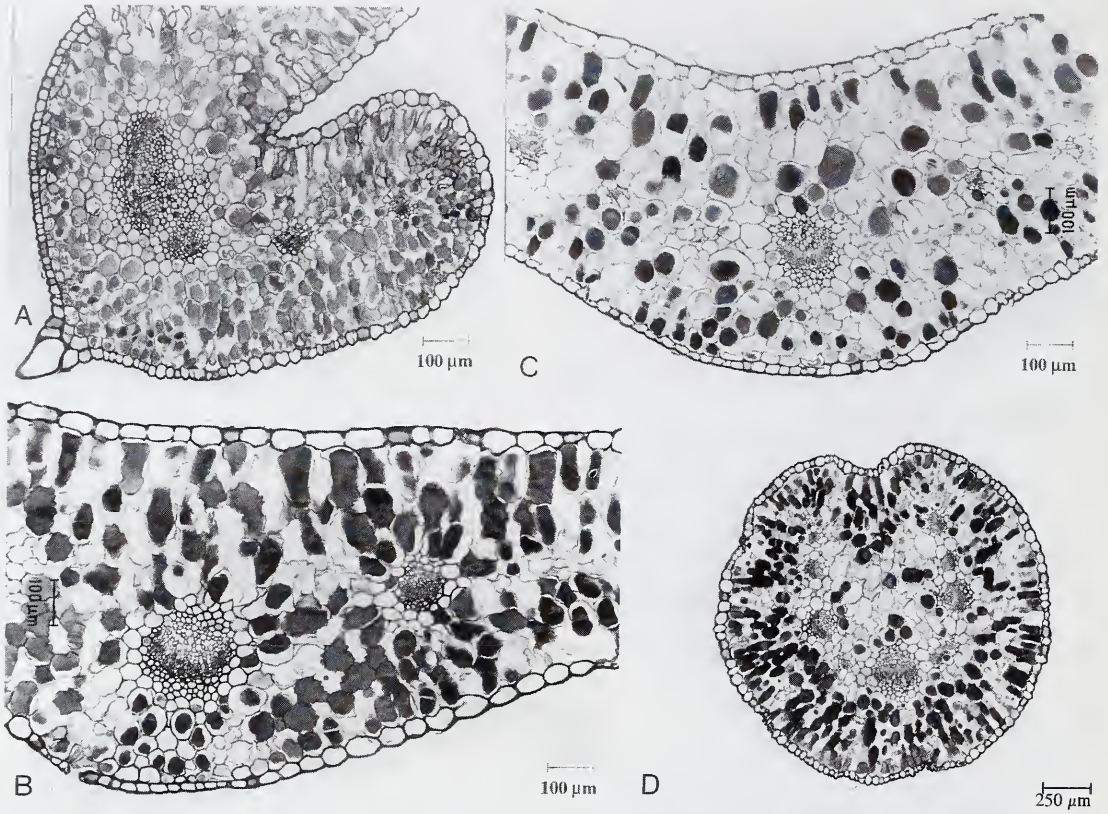


FIGURE 3.—Transverse sections of terminal leaflets of *P. laevigatum*. A, subsp. *laevigatum*, Maggs 16; B, subsp. *diversifolium*, Van der Walt 1603. C, D, subsp. *oxyphyllum*: C, flattened leaf, Van der Walt 1501; D, centric leaf, Van der Walt 1604.

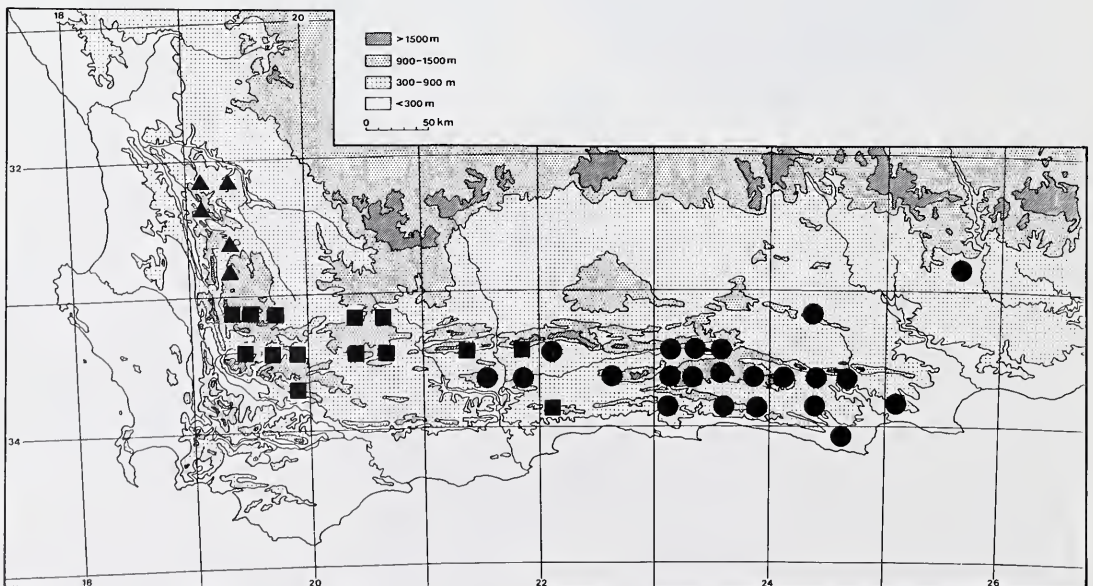


FIGURE 4.—Known geographical distribution of *P. laevigatum*: subsp. *laevigatum*, ●; subsp. *diversifolium*, ■; subsp. *oxyphyllum*, ▲.

2. subsp. **diversifolium** (Wendl.) Schonken stat. nov.

Pelargonium diversifolium Wendl., Botanische Beobachtungen: 52 (1798); Willd.: 664 (1800); Pers.: 230 (1806); Wendl.: 53 (1809). Iconotype: Wendland, Collectio plantarum 2,4: t. 58 (1809).

Geranium trifoliatum Andr.: (1805). *Pelargonium trifoliatum* (Andr.) Sweet: 294 (1826). Iconotype: Andrews, Geraniums c. ic. (1805).

Diagnostic morphological features

Leaves unifoliate to trifoliate, pinnae not incised, hirsute to densely hirsute, flattened, 1–2 flowers per pseudo-umbel (Figure 5).

Diagnostic anatomical features of leaves

Petiole: adaxially flattened, glandular hairs multicellular, non-glandular hairs unicellular, hypodermis clearly differen-

tiated, parenchymatous cortex 5–6 layers, extraxylary sclerenchyma cylinder continuous and 2–6 layers wide, main vascular bundles 4, smaller bundles 4–8, medullary bundle 1 or 0 (Figure 2B). *Lamina*: flattened, trichomes as on petiole, more stomata abaxially, mesophyll differentiated in palisade and spongy parenchyma, 2 adaxial palisade layers larger than 1 abaxial layer (Figure 3B).

Specimens examined

WESTERN CAPE.—3319 (Worcester): Agter-Witzenberg, (–AB), *Marais* 47 (STEU); Elandsfontein, Skurweberge, (–AB), *Schlechter* 1750 (PRE), 10020 (BOL, E, MO, P, PRE, W, Z); 11 km N of Gydouw Pass, (–AB), *Hutchinson* 1040 (BOL), *Van der Walt* 1603 (STEU); Farm Merino, Theronberg, (–AD), *Cillie* 686 (STEU); Baviaansberg, Ceres, (–BA), *Compton* 12850 (NBG), *Stokoe s.n.* (SAM); Ertjieslandkloof, Ceres, (–BA), *Wilman* 2266 (BOL, MO); Hottentotskloof, (–BC), *Pearson* 4945 (BOL); Bokkerivier farms, Ceres, (–BD), *Barker* 10144 (NBG), *Booyesen* 60 (NBG); between Concordia and Triangle, (–BD), *Barnard* 754 (SAM); Bonteberg, Worcester, (–BD), *Compton* 9936 (NBG), *Esterhuysen* 3712 (BOL); Eendracht, (–DB), *Lewis* 1777 (SAM), 3320

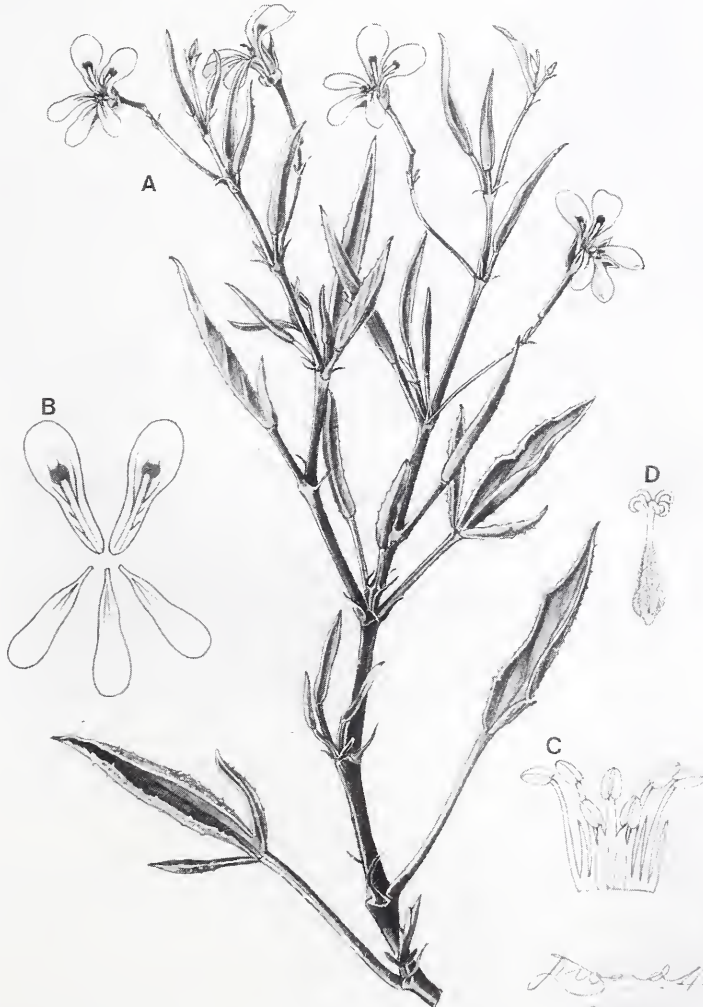


FIGURE 5.—*P. laevigatum* subsp. *diversifolium*, Ward-Hilhorst 111. A, flowering branch, $\times 0.8$; B, petals, $\times 1.6$; C, androecium, $\times 3.2$; D, gynoecium $\times 3.2$.



FIGURE 6.—*P. laevigatum* subsp. *oxyphyllum*, Ward-Hilhorst 210. A, flowering branch, $\times 0.7$; B, petals, $\times 1$; C, androecium, $\times 3$; D, gynoecium, $\times 3$.

(Montagu): Tweedside, (–AB), *Barker* 20602 (BOL), *Marloth* 10848, 12096 (PRE, STE), *Van der Walt* 1592 (STEU); Cabidu, (–AB), *Hall* 171 (NBG), *Oliver s.n.* (NBG); Pieter Meintjies, (–AD), *Rogers* 17887 (PRE); Witteberg, (–AD/BC), *Adanson s.n.* (BOL), *Compton* 2680 (BOL), 12213 (NBG); Matjiesfontein, (–BA), *Marloth* 2961 (BOL, PRE); Whitehill, (–BA), *Compton* 7957 (NBG), Fisantekraal, (–BC), *Compton* 21110 (NBG), 3321 (Ladismith); Elandskloof between Vleiland and Seweweekspoort, (–AD), *Maggs* 28 (STEU); Ladismith, (–BD), *Geldenhuis* 454 (STE); Rietkloof, (–BD), *Lewis* 1168 (SAM), 3322 (Oudtshoorn); Robinson Pass, (–CC), *Taylor s.n.* (BOL).

Subsp. *diversifolium* occurs from Gydouw near Ceres eastwards to the Robinson Pass between Oudtshoorn and Mossel Bay (Figure 4). It is often found in mountainous habitats in a variety of vegetation types. Its distribution area falls entirely in the winter rainfall region, but it usually occurs on the lower slopes of mountains or on hills where the rainfall is relatively low in comparison to habitats higher up on the mountains.

3. subsp. *oxyphyllum* (DC.) Schonken stat. nov.

Pelargonium oxyphyllum DC., *Prodromus systematis naturalis regni vegetabilis* 1: 667 (1824); Drège: 209 (1843). Type: locality and collector

unknown, specimen G-DC 667-190 with De Candolle's handwriting (holo!).

P. laevigatum (L. f.) Willd. var. *oxyphyllum* (DC.) Harv.: 297 (1860).

Diagnostic morphological features

Leaves trifoliate, pinnae not incised, glabrous, subterete to flattened, usually 1 flower per pseudo-umbel (Figure 6).

Diagnostic anatomical features of leaves

Petiole: adaxially flattened to cordiform, without trichomes, hypodermis not clearly differentiated, parenchyma cortex 5–6 cell layers, extraxylary sclerenchyma cylinder continuous and 2–5 layers wide, main vascular bundles 4, smaller bundles 6–8, medullary bundle 1 or 0 (Figure 2C). *Lamina*: more or less flattened to centric, more stomata abaxially, mesophyll differentiated in palisade and spongy parenchyma, 1 adaxial palisade layer

larger than 2 abaxial layers, mesophyll in centric leaves not clearly differentiated (Figure 3C, D).

Specimens examined

WESTERN CAPE.—3219 (Wupperthal): Heuningvlei, Wupperthal road, (–AA), *Schonken* 86 (STEU); Middelberg, (–AA/AC), *Compton* 7503 (NBG); *Kerfoot* 6150 (NBG); Sneekop road, (–AC), *Strauss* 63 (NBG); between Algeria and Dwarsrivier, (–AC), *Schonken* 81 (STEU); Hoogvertoon, (–AC), *Haynes* 1205 (PRE, STE); Cedarberg, (–AC), *Van der Walt* 1604 (STEU); Matjesrivier, (–AC), *Wagener* 281 (NBG); Dwarsrivier, (–AC), *Rycroft* 2641 (MO, NBG, STE); Tafelberg, (–AC), *Barnard* s.n. (SAM), *Lamb* 1 (STE); between Eselbank and Wupperthal, (–AC), *Van der Walt* 1501, 1502 (STEU); Eselbank, (–AC), *Drège* s.n. (MEL, PRE); Wupperthal, (–AC), *Stirton* 6401 (PRE, STEU), *Thode* A1965 (NH, PRE); Gideonskop, (–CB), *Stokoe* s.n. (NBG); Juriesberg, (–CB), *Compton* 12742 (NBG); Zoo Ridge, Suurvlaakte, (–CD), *Taylor* 6120 (PRE, STE); Skurweberge E of Citrusdal, (–CD), *Prismos* s.n. (SAM).

Subsp. *oxyphyllum* is confined to the Cedarberg Range, occurring from Heuningvlei in the vicinity of Wupperthal southwards to the district of Citrusdal (Figure 4). It grows in flat areas on deep sandy soil derived from sandstone. The annual rainfall in its distribution area varies from 200–500 mm.

DISCUSSION

P. laevigatum is taxonomically a complicated species because it displays a high degree of phenoplasticity. Almost all the populations studied have unique combinations of characters. The floral structure and many leaf characters of the plants investigated are, however, basically identical and therefore it was decided to consider them as conspecific. The three subspecies which are distinguished, have the same somatic chromosome number of $2n = 22$. The rank of subspecies rather than variety was chosen for the three infraspecific taxa because they are allopatric.

The phenoplasticity of the species is also reflected in the leaf anatomy. The leaflets of subsp. *oxyphyllum* for example vary from flattened to centric. A medullary vascular bundle can be present or absent in the petioles of all three subspecies, even in different leaves of the same plant. The occurrence of hairs on the leaves of subsp. *laevigatum* is also extremely variable. Anatomical features of the leaves of *P. laevigatum* are therefore of limited taxonomic importance.

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A systematic study of the genus *Pseudopentameris* (Arundinoideae: Poaceae)

N.P. BARKER*

Keywords: Arundineae, Arundinoideae, conservation, leaf anatomy, phenetics, phylogenetics, Poaceae, *Pseudopentameris*, systematics

ABSTRACT

The genus *Pseudopentameris* Conert is examined morphologically and anatomically. A phenetic study of the morphologically variable species *P. macrantha* indicates that two taxa should be recognised. One of these, *P. caespitosa* N.P. Barker, is described as new. In addition, the study supports the inclusion of *Pentameris obtusifolia* in *Pseudopentameris*. The genus *Pseudopentameris* is re-delimited to accommodate the new taxa, and a key to species is provided. Details of the cytology, phylogeny and conservation status of taxa in the genus are also discussed.

UITTREKSEL

Die genus *Pseudopentameris* Conert word morfologies en anatomies ondersoek. 'n Fenetiese ondersoek van die variërende spesie *P. macrantha* toon dat twee taksons erken moet word. Een van hulle, *P. caespitosa* N.P. Barker, word as nuut beskryf. Verder ondersteun die ondersoek die insluiting van *Pentameris obtusifolia* in *Pseudopentameris*. Die genus *Pseudopentameris* word heromgrens om die nuwe taksons te huisves, en 'n sleutel tot die spesies word verskaf. Besonderhede van die sitologie, filogenie en bewaringstatus van taksons in die genus word ook bespreek.

INTRODUCTION

The genus *Pseudopentameris* Conert is endemic to the lowland fynbos of the southwestern Cape Province, South Africa. This genus was created by Conert (1971), who thought that two species of the genus *Danthonia* DC., *D. macrantha* Schrad. and *D. brachyphylla* Stapf, merited recognition as a separate genus. This new genus was characterised by unusually large spikelets which, while similar to both those of *Pentameris* P. Beauv. and *Danthonia*, differed in having many-nerved glumes. The nature of the fruit of these two species also set them apart.

Studies of the leaf anatomy (discussed below) provided further evidence of their singularity (De Wet 1956, 1960; Ellis 1985a). Ellis (1985b) observed that the leaf anatomy of the taxon he called *Pentameris sp. nov.*, bore a strong resemblance to the anatomy of the two known species of *Pseudopentameris*, and postulated a hybrid origin for this species. Additional studies on the fruit morphology (Barker 1986, 1989, 1993) and leaf anatomy (presented below) also suggested that this unusual species has close affinities with the other species of *Pseudopentameris*. Because of the nomenclatural confusion surrounding this taxon (see 1. *Pseudopentameris obtusifolia* below), past studies have referred to it by a number of names. Barker (1989) and Ellis (1985b) referred to it as *Pentameris sp. nov.* whereas Linder & Ellis (1990) refer to it as *Pentameris squarrosa* Stapf. Some herbaria (in particular PRE and STE) misapplied this name to the taxon now known as *Pentameris oerophila* N.P. Barker (1993), whereas BOL has used the synonym *Pentameris squarrosa* Stapf.

This study encapsulates all these observations, and documents the anatomical and morphological variation within the genus, and presents the relevant nomenclatural modifications that are required as a result of these observations.

MORPHOLOGY

Pseudopentameris is unusual in having two species (*P. macrantha* and *P. obtusifolia*) with aerial stems that possess the anatomy of a rhizome (H.P. Linder unpublished). Until the anatomy and homology of these structures is better understood, the term 'stem' is used, as it serves to differentiate this structure from below-ground rhizomes and the annually produced flowering culm.

These stems are often branched, and the annual flowering culms are produced from their apical buds. Subsequent shoot growth takes place from what Linder & Ellis (1990) term caulescent innovation buds on the stems, which results in branched stems. This branching can lead to a shrub-like growth form in older plants. This type of growth form has also been described in some species of *Pentameris* (Barker 1993). In *Pseudopentameris obtusifolia* these branched aerial stems are scandent, spreading out from the base of the plant, over and between the other vegetation. Linder & Ellis (1990) illustrate this species (named in their work as *P. squarrosa*) and consider its unusual growth form to be an adaptation enabling the plant to survive long interfire periods that are characteristic of the fynbos biome. The two species which do not have these stems (*P. brachyphylla* and *P. caespitosa sp. nov.* described below) produce the annual flowering culm from an underground rhizome that can become fibrous or woody in older plants.

In *P. obtusifolia* the stems are covered by the persistent remains of the leaf sheaths, the dead leaf blades being

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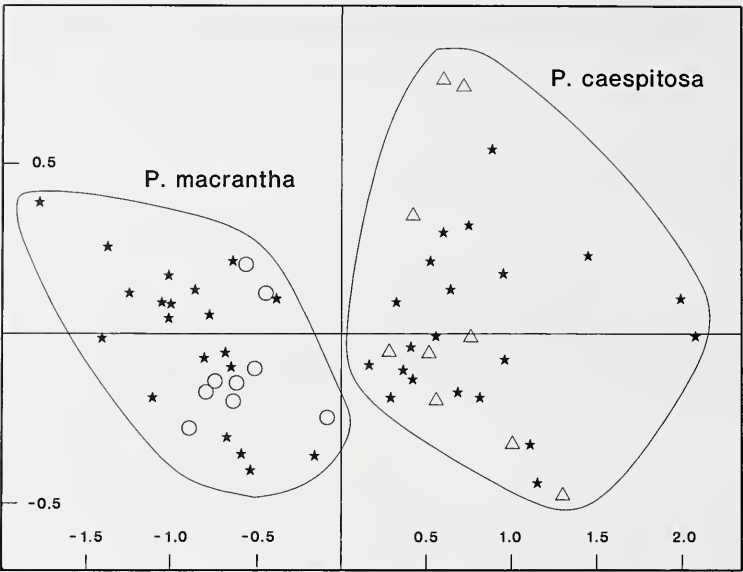


FIGURE 1.—First two axes of Principal Components Analysis (PCA) of 59 specimens matching the previous description of *Pseudopentameris macrantha*. Specimens measured for six floral characters. First axis: 81.7% of variation present in data. Second axis: 6.8%. Lines drawn around two groups were placed by eye. Each symbol represents an individual specimen. Specimens with rhizomatous growth form, *P. macrantha*, ○; specimens with caespitose growth form, *P. caespitosa*, △; specimens with no recorded growth form, ★.

deciduous. In the other species in the genus, the dead leaf blades are persistent, and in *P. brachyphylla* (Stapf) Conert they curl in a characteristic manner at the base of the plant. The living leaf blades are short, open to rolled and rigid in *P. obtusifolia*, but long, somewhat flexuous and open to rolled in the other species.

The inflorescence is a contracted panicle, which becomes somewhat lax during anthesis and comprises 8–80 spikelets. Spikelet size is variable between the species. The glumes are 3-nerved in *P. obtusifolia* (the lateral veins are visible only at the base of the glumes) and 5–9-nerved in the other species. The lemmas are variously pubescent, with a geniculate central awn. The lemma lobes are acuminate and variously adnate to the lateral bristle. The palea is bicarinate, bifid at the apex and longer than the lemma body. The lodicules are many-nerved (G.A. Verboom unpublished data), cuneate, glabrous or ciliolate. The latter condition is developed to the extreme in *P. obtusifolia*, which has densely ciliolate lodicules, the cilia being as long as the lodicule bodies.

Each floret has three large anthers (up to 9 mm). The ovaries of all taxa possess what Barker (1990, 1994) termed pseudostigmata. These structures have the appearance of stigmatic hairs, and arise from the region between the points of origin of the style branches, although the style branches themselves appear to be absent (or alternatively have stigmata along their entire length, from the apex of the ovary upwards). As the pseudostigmata are easily deciduous, they are seldom observed on mature fruit. Their presence may, however, explain the references by De Wet (1954b) and Tomlinson (1985) to hairs which are decurrent on the inner side of the caryopsis and join over the top of the ovary. A similar description of these structures is given by Chippindall (1955). These features, although not labelled as pseudostigmata, appear in the figures published by Barker (1986, 1990). The fruit is a caryopsis (Clayton & Renvoize 1986), up to 6 mm long, with a long, canaliculate hilum extending almost the full length of the fruit. The embryo is a quarter to a fifth the length

of the fruit (Conert 1971; Barker 1986, 1989, 1990). The surface of the caryopsis is reticulate (Barker 1986, 1989).

Barker (1990) noted substantial variation in the size of the floral parts in specimens identified as *P. macrantha*. This prompted an additional study in which measurements of six floral characters from 59 specimens were taken, including those examined in the earlier study. The phenetic package NTSYS-pc version 1.4 (Numerical Taxonomy and SYStematics package; Rohlf 1988) was used to perform a Principal Components Analysis (PCA).

The first three principal components (axes) account for 92.9% of the variation in the data. When the specimens are plotted out on the first two axes (accounting for 88.5% of the variation), two clusters are apparent (Figure 1). Each cluster contains specimens from a wide geographic area, and the geographic areas of the two clusters overlap extensively. Furthermore, specimens from each cluster have been observed to co-occur. Despite this sympatric distribution, a one-sided T-test showed that the differences in the means of each of the six characters from the two clusters were statistically significant at a 99.9% confidence interval. Table 1 presents the sample means and standard deviations of these characters in each cluster.

TABLE 1.—Sample means and standard deviations (mm) for six quantitative floral characters of two clusters of specimens corresponding to *P. macrantha* and *P. caespitosa*. A one-sided T-test shows that differences between means for all characters are significant at 99.9% confidence interval

Floral part	<i>P. macrantha</i>		<i>P. caespitosa</i>	
	Mean	Std. dev.	Mean	Std. dev.
Glume	37.14	5.747	46.16	5.755
Lemma	6.43	0.884	8.80	0.772
Awn: base-knee	8.03	1.488	13.30	2.049
Awn: knee-tip	14.58	2.220	23.38	4.286
Bristle	12.17	1.594	20.52	3.024
Palea	9.75	0.967	12.98	1.185

A character not included in the PCA, but overlaid onto the PCA plot, is that of growth form, as related to the presence of the branching stems. This feature was observed in the field for some of the specimens included in the PCA, and the position in the PCA plot of these specimens is shown in Figure 1 by means of open symbols. As can be seen from Figure 1, each cluster has a specific growth form. The cluster with the smaller floral parts includes specimens with branching stems, whereas the specimens with larger floral parts do not possess stems. These two clusters are considered here to be two species: *P. macrantha* and *P. caespitosa* N.P. Barker *sp. nov.* Descriptions and details on nomenclature of these two species appear below.

LEAF ANATOMY

Pseudopentameris has been well examined anatomically by De Wet (1956, 1960), Renvoize (1981), Ellis (1985a), Tomlinson (1985) and Barker (1990). The genus as a whole possesses a sclerophyllous type of arundinoid leaf anatomy (Ellis & Linder 1992). Ellis (1985a) found minor anatomical differences between *P. macrantha* and *P. brachyphylla*. The anatomy of *P. obtusifolia* is only slightly different from the former two species (Ellis 1985b). All the taxa share characters such as the presence

of large, inflated abaxial epidermal cells, dumbbell-shaped silica bodies and the absence of abaxial micro- and macrohairs. This knowledge was supplemented in this study by a Scanning Electron Microscope (SEM) survey of the leaf epidermides of all the species in the genus.

The SEM study of both adaxial and abaxial leaf anatomy was carried out on leaf blade material of nine herbarium specimens of *P. macrantha*, nine specimens of *P. caespitosa*, five specimens of *P. brachyphylla* and 11 specimens of *P. obtusifolia*. Leaf material was mounted on SEM stubs and then coated in gold-palladium. The specimens were examined using an ISI-SX-25 Scanning Electron Microscope.

The abaxial epidermis of all specimens examined lacked both microhairs and macrohairs and, as noted by Ellis (1985a), the abaxial epidermides of all the species are almost indistinguishable. However, occasional needle-like prickles were observed. Figure 2A illustrates the abaxial epidermis of *P. obtusifolia*.

The adaxial epidermides of *P. macrantha*, *P. caespitosa* and *P. brachyphylla* were almost identical (Figure 2B, C), but the epidermis of *P. obtusifolia* differed, in that it had a denser distribution of prickles (Figure 2D). In all the

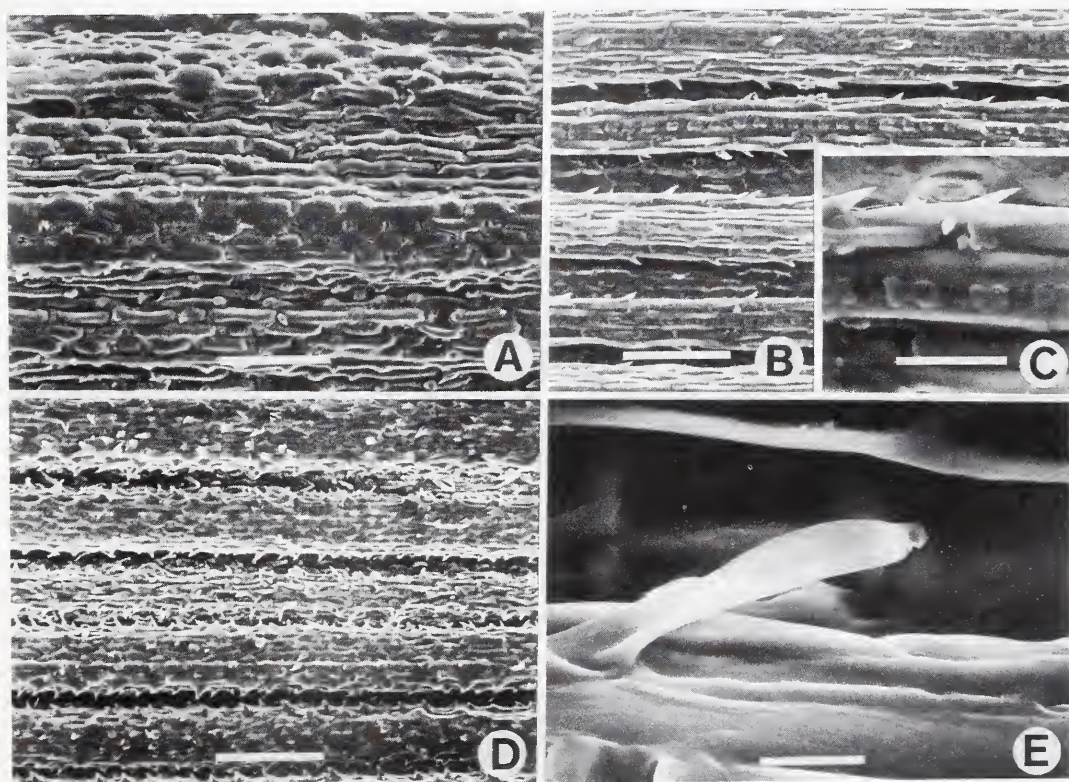


FIGURE 2.—Leaf blade SEM of *Pseudopentameris*. A, D, *P. obtusifolia*, Ellis 2342: A, abaxial epidermis showing large inflated epidermal cells and small prickles; D, deeply ribbed adaxial epidermis heavily adorned with prickles. B, *P. brachyphylla*, Boucher 357a, adaxial epidermis showing open furrows and ribs with prickles. C, E, *P. macrantha*, Ellis 2515: C, adaxial prickles, note also dumbbell-shaped silica bodies; E, microhair from adaxial epidermis, note minute apical cell. Scale bars: A, 225 μ m; B, 240 μ m; C, 115 μ m; D, 325 μ m; E, 17 μ m.

species, the prickles are needle-like and angled almost parallel to the epidermis. These prickles appear to be modifications of the epidermal cell surface (shown magnified in Figure 2C). These prickles are unlike those found in *Pentameris* (Barker 1993), *Pentaschistis* (Ellis & Linder 1992) and at least one species of *Merxmüllera* (Barker & Ellis 1991). The prickles of these latter taxa are slightly inflated basally, variable in length but longer than in *Pseudopentameris*, and protrude away from the epidermis.

Microhairs with minute, deflated apical cells were observed at the bottom of the adaxial furrows (Figure 2E). These bicellular microhairs are similar, except in size, to those reported in *Pentameris* (Barker 1993). Microhair size ranged from 55–67 μm , with a mean of 64.8 μm (five samples), and (unlike in *Pentameris*) no species level size differences were apparent. No microhairs were observed on the abaxial leaf surface.

The presence, distribution and nature of microhairs in this genus has been a contentious issue. De Wet (1956, 1960) implies that, as *Pseudopentameris* has a panicoid epidermis, bicellular hairs (microhairs) would be present, presumably on the abaxial surface. In contrast, Renvoize (1981) considered microhairs to be absent, but later he described 'long slender papillae, which in a few instances appear to bear the remains of a thin-walled apical cell' which were associated with the adaxial surface (Renvoize 1986). This description matches the structure shown in Figure 2E, and it appears that these papillae are in fact microhairs.

CYTOLOGY

The cytology of the genus *Danthonia* was examined by De Wet (1953, 1954a, b), who was of the opinion that the base chromosome number of this group is $x = 6$. The subsequent division of the genus *Danthonia* resulted in limited cytological knowledge for each of the segregate genera. Additional research by Spies & Du Plessis (1988) and Du Plessis & Spies (1988) has increased cytological knowledge about the *Danthonia* segregates but no chromosome counts of the species of *Pseudopentameris* have been published. From analyses of the relationship between stomatal size and chromosome counts, De Wet (1954a) predicted a count of $2n = 24$. This figure is credible, as many of the African arundinoid genera display intraspecific polyploidy (see the study on *Chaetobromus* by Spies *et al.* 1990).

CONSERVATION STATUS

Two species in the genus are mentioned in local conservation texts. *Pseudopentameris obtusifolia* (under the name of *Pentameris obtusifolia*) is listed by Hall *et al.* (1980) as a threatened species, the conservation status of which is given as 'uncertain'. However, owing to the nomenclatural difficulties experienced with this taxon (discussed below and in Barker 1993) and the lack of voucher citations, the exact identity of this taxon is not certain. *Pseudopentameris brachyphylla* is considered by Bond & Goldblatt (1984) to be rare, as it is restricted to the Caledon area. Both these species are restricted to relatively small areas at a low to mid altitude. Therefore, although

not presently under threat, their narrow habitat range places them in a category that may best be described as 'potentially threatened'.

PHYLOGENETIC RELATIONSHIPS

The genus *Pseudopentameris* now contains four species. These species are united by an unusual fruit morphology and the presence of pseudostigmata (described above). This fruit morphology is rare in the southern African Arundineae. The only other arundinoid taxon with a similar fruit type is *Chaetobromus* Nees, the fruit of which are somewhat smaller, but similar in all other respects except the possession of pseudostigmata (Barker 1994). The close relationship between these two genera is further supported by DNA-based molecular studies (Barker *et al.* in prep.). As *Pseudopentameris* has both anatomical and morphological autapomorphies (the presence of inflated abaxial epidermal cells and the presence of the pseudostigmata on the apex of the ovary) the genus is distinct from *Chaetobromus*, and the two genera ought not to be combined. Autapomorphies for *Chaetobromus* include spikelets which disarticulate below the glumes and dimorphic florets. In *Pseudopentameris*, and many other arundinoid genera, the spikelets disarticulate above the glumes. *Chaetobromus* is the only arundinoid genus which has dimorphic florets: the basal ones are glabrous, the upper ones variously hirsute.

Affinities between *Pseudopentameris* and other 2-flowered arundinoids, *Pentameris* and *Pentaschistis*, have also been postulated (e.g. Ellis 1985b; Ellis & Linder 1992). *Pentameris* is presently defined by fruit characters (an achene with an apical crown of hairs; Barker 1993), whereas *Pentaschistis*, as presently defined, has no obvious autapomorphy, and may include both *Pentameris* and *Prionanthium* Desv. (H.P. Linder pers. comm.). While the presence of 2-flowered spikelets may indicate some degree of relationship of *Pseudopentameris* to these genera, other features such as the sclerophyllous type of arundinoid leaf anatomy suggest that these relationships extend beyond these taxa to genera such as *Merxmüllera*. The assessment of phylogenetic relationships of *Pseudopentameris* and other arundinoid taxa therefore needs to be done in the broadest possible context, and should include all taxa and not be restricted to the southern African genera. Such a study is presently under way (H.P. Linder *et al.* in prep.).

TAXONOMY

***Pseudopentameris* Conert** in Mitteilungen der Botanischen Staatssammlung, München 10: 304 (1971). Type species: *Pseudopentameris macrantha* (Schrad.) Conert.

Plants perennial; caespitose, scandent or sometimes branched. *Stems* 0.4–1.4(–2) m long, woody and persistent or herbaceous from woody base; flowering culms up to 0.8 m long. *Leaves*: sheaths appressed to culm, persistent; sheath mouth sometimes auriculate; ligule a fringe of hairs; leaf blades linear, 25–500 mm long, rigid or soft, open and flat to rolled and rigid. *Inflorescence* paniculate, lanceolate and somewhat contracted. *Spikelets* 6–80, laterally compressed, 2-flowered, highly reduced third floret

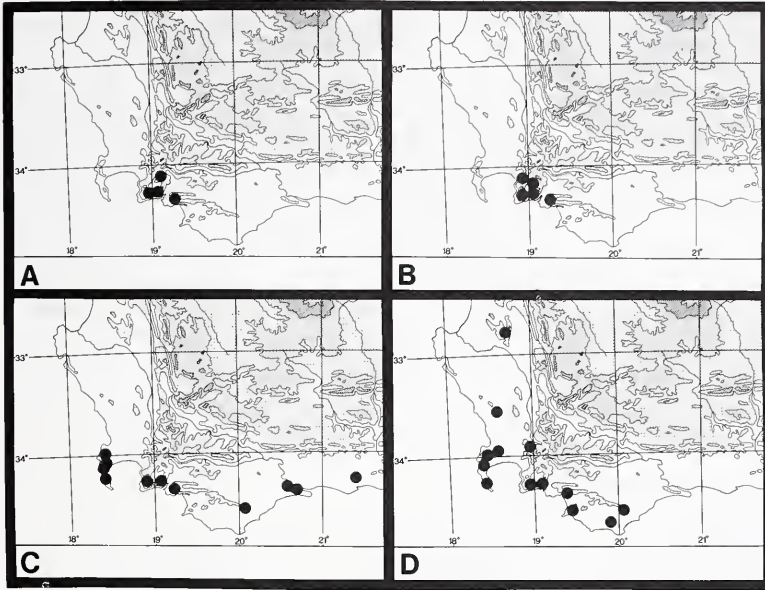


FIGURE 3.—The distribution of *Pseudopentameris* spp. in the southwestern Cape, South Africa. A, *P. obtusifolia*; B, *P. brachyphylla*; C, *P. macrantha*; D, *P. caespitosa*.

rarely present; *glumes* two, more or less equal, 18–60 mm long, 3–7(–9)-nerved, chartaceous, minutely scabrid or glaucous; *lemma body* chartaceous to cartilaginous, variously pubescent, 4.5–11.0 mm long, 7–9-nerved, nerves anastomosing into awn base and 8–27 mm long lateral bristle; *lemma lobes* 1.5–4.5 mm long, acute to acuminate, partly to fully adnate to bristles; *central awn* geniculate, scabrid, contorted basally, 5–17 mm long from base to knee, 12–34 mm long from knee to tip; *palea* longer than lemma body, bifid at apex. *Lodicules* two, glabrous, sparsely to densely ciliate. *Stamens* three, 4.5–9.0 mm long. *Ovary* glabrous, with apical pseudostigmata, styles short to absent. *Fruit* a caryopsis, 4–6 mm long, hilum $\frac{7}{8}$ as long as fruit, embryo $\frac{1}{2}$ as long as fruit, surface reticulately sculptured.

Key to species

- 1a Lower glumes 18–25 mm long, 3-nerved basally, central nerve extending the length of glume; lodicules densely ciliate 1. *P. obtusifolia*
- 1b Lower glumes (27–)35–60 mm long and (3–)5–9-nerved; lodicules sparsely ciliate or glabrous:
 - 2a Lemmas pubescent over entire abaxial surface . . . 2. *P. brachyphylla*
 - 2b Lemmas basally glabrous, apically pubescent, including lemma lobes:
 - 3a Lemma body 5–8 mm long; awn (knee to tip) 11–18 mm long; lemma bristle 9–15 mm long; plants with branched above-ground stems, especially in older plants 3. *P. macrantha*
 - 3b Lemma body 8–10 mm long; awn (knee to tip) 17–27 mm long; bristle 15–30 mm long; plants with woody or fibrous underground base, branched above-ground stems absent 4. *P. caespitosa*

1. *Pseudopentameris obtusifolia* (Hochst.) N.P. Barker

Danthonia obtusifolia Hochst. in Flora 29: 120 (1846); Stapf: 536 (1899). *Pentameris obtusifolia* (Hochst.) Schweick.: 91 (1938); N.P. Barker in Gibbs Russell et al.: 252 (1990). Type: Pr. b. spei, Ludwig s.n. (OXF, iso.(?)).

Avena rigida Steud.: 482 (1829), non *A. rigida* M. Bieb. (1808). *Danthonia rigida* Steud.: 243 (1855). Type: Pr. b. spei, Ludwig s.n. (OXF, holo.! or iso.).

Pentameris squarrosa Stapf: 515 (1899); Linder & Ellis: 91–103 (1990). Type: Caledon Div., Nieuw Kloof in Houw Hoek Mountains, Burchell 8076 (K, holo.; PRE, iso.).

Pentameris sp. nov., Ellis: 567 (1985b); Barker: 136 (1989).

Plants perennial; scandent, sometimes branched. *Stems* branching, 0.4–1.5(–3.0) m long, woody and persistent, flowering culms produced annually from apical growth points. *Leaves*: sheaths appressed to culm, persistent; sheath mouth slightly bearded; leaf blades linear, 25–120 mm long, somewhat rolled and rigid. *Inflorescence* panicle, lanceolate and contracted. *Spikelets* 8–45, laterally compressed, 2-flowered; *glumes* two, more or less equal, 18–25 mm long, chartaceous, minutely scabrid, 3-nerved basally, central nerve extending to glume apex; *lemma body* uniformly pubescent, 4.5–6.0 mm long, 9-nerved, nerves anastomosing into awn base and a 8–12 mm long lateral bristle; *lemma lobes* 1.5–3.0 mm long, acute to acuminate, partly to fully adnate to bristles; *central awn* geniculate, scabrid, contorted basally, 7.5–11.0 mm long from base to knee, 12–16 mm long from knee to tip; *palea* longer than lemma body, bifid at apex. *Lodicules* two, densely ciliate, cilia as long as lodicule body. *Stamens* three, 4.5–7.5 mm long. *Ovary* glabrous, with apical pseudostigmata, styles short to absent. *Fruit* 4 mm long. Flowering time November to January. The known distribution of this species is indicated in Figure 3A.

Schweickerdt (1938) points out that Steudel (1829) and Hochstetter (1846) probably described new taxa from duplicate material collected by Baron von Ludwig. Hochstetter called his species *Danthonia obtusifolia* Hochst., whereas Steudel named the material *Avena rigida* Steud. Schweickerdt showed that the name *Avena rigida* had been used earlier by Marschall von Bieberstein (1808) and therefore Steudel's later homonym is rejected. The Ludwig specimen at OXF bears the name *Avena rigida*, and is considered to be the

holotype or perhaps an isotype of this name. The specimen seen by Hochstetter was not traced, so the same specimen (Ludwig specimen at OXF) is considered to be probably the isotype of the name *Danthonia obtusifolia*. Hochstetter's (1846) *D. obtusifolia* has priority over Stapf's (1897) *D. squarrosa*. Schweickerdt notes that had Stapf seen the type material on which Steudel had based his description, he would have been able to identify his species as *Danthonia obtusifolia* Hochst.

The type of Stapf's *Pentameris squarrosa* is a Burchell specimen, *Burchell 8076*. There is a fragment of this specimen in PRE, which originates from Kew. The envelope is annotated by Schweickerdt, who wrote 'a fair match of the type of *Avena rigida* Steud. in the Herb. Fielding, Oxford'. This fragment, consisting of two leaves and two spikelets, comprises sufficient material to allow comparison on the basis of a number of characters. It is a good match of the type specimen of *Avena rigida*. It can therefore be confirmed that *Pentameris squarrosa* is a synonym of *Pseudopentameris obtusifolia*.

This nomenclatural confusion is reflected in past studies and curatorial practices (cited above). The use of these confusing names without voucher citations in red data books (e.g. Hall *et al.* 1980) results in further confusion and renders the information in such texts meaningless. In order to assist in the identification and curation of specimens of this taxon, an extended list of voucher specimens is provided. The herbarium code JF is used for the herbarium at Jonkerhoek Forestry Station.

Vouchers: *N. Barker 300, 331, 332, 333* (PRE); *Burchell 8076* (PRE); *Ellis 2342* (PRE); *Esterhuysen 29029, 35396* (BOL, PRE); *Esterhuysen 35416* (BOL); *Haynes 770* (JF, PRE, STE); *Hilton-Taylor 350, 351, 352, 353* (PRE); *Kruger KR565* (JF); *Levy's 10460* (BOL); *Macdonald 634* (PRE, STE); *Stokoe 7197* (BOL); *Taylor 3023* (PRE, STE).

2. *Pseudopentameris brachyphylla* (Stapf) Conert in *Mitteilungen der Botanischen Staatssammlung*, München 10: 304 (1971); N.P. Barker in Gibbs Russell *et al.* 278 (1990). Type: Locality unknown, *Zeyher 1826a* (K, holo.).

Danthonia brachyphylla Stapf: 520 (1899).

Plants perennial, caespitose, bases woody and fibrous. *Stems* absent. *Culms* 400–750 mm long. *Leaves*: sheaths appressed to culm, persistent; sheath mouth slightly auriculate; leaf blades 45–150 mm long, open and flat or folded. *Inflorescence* panicle, lanceolate and contracted. *Spikelets* 8–20, laterally compressed, 2-flowered, highly reduced third floret rarely present; *glumes* two, more or less equal, 27–37 mm long, 5–7-nerved, chartaceous, minutely scabrid; *lemma body* cartilaginous, uniformly pubescent, 5.5–6.5 mm long, 7–9-nerved, nerves anastomosing into awn base and 12–20 mm long lateral bristle; *lemma lobes* 2.0–3.5 mm long, acute to acuminate, partly to completely adnate to bristles; *central awn* geniculate, scabrid, contorted basally, 7.5–11.0 mm long from base to knee, 12–20 mm long from knee to tip; *palea* longer than lemma body, bifid at apex. *Lodicules* two, glabrous or sparsely ciliolate. *Stamens* three, 5–8 mm long. *Ovary* glabrous, with apical pseudostigmata, styles short to absent. *Fruit* 4.5–6.0 mm long. Flowering time

September–October. The distribution of this species is given in Figure 3B.

The holotype, *Zeyher 1826a* housed at Kew is accompanied by drawings and annotations in Stapf's hand. Conert (1971) also cites this specimen, and it carries a 'det. slip' bearing his signature. Although the type locality is not known, PRE has a Zeyher collection of the same taxon, *Zeyher 1825b*, collected at Hemel en Aarde, Swellendam. Although speculative, it is possible that these consecutively numbered Zeyher specimens were both collected from this locality.

Vouchers: *N. Barker 731* (PRE); *Burnan 1180* (BOL); *De Vos 1401* (STE); *Esterhuysen 33258* (BOL, PRE); *Williams 2542* (NBG, PRE).

3. *Pseudopentameris macrantha* (Schrader) Conert in *Mitteilungen der Botanischen Staatssammlung*, München 10: 304 (1971); N.P. Barker in Gibbs Russell *et al.* 279 (1990). Type: Table Mountain above Kirstenbosch, *White 5518* (PRE, neo! here designated).

Danthonia macrantha Schrad. in J.A. Schultes: 385 (1824); Trinius: t. 63 (1827); *Pentameris macrantha* (Schrader) Nees: 312 (1832). Type: P.B.S., Hesse, s.n. (not traced).

Plants perennial, basally woody, caespitose, becoming shrub-like with age. *Stems* branched, 0.5–1.4 m long, covered in persistent leaf sheaths. *Culms* 0.5–0.8 m long. *Leaves*: sheaths appressed to culm, persistent; sheath mouth somewhat auriculate; leaf blades 45–350 mm long, open and flat or rolled and filiform. *Inflorescence* panicle, lanceolate and somewhat contracted. *Spikelets* 10–25(–50), laterally compressed, 2-flowered, highly reduced third floret rarely present; *glumes* two, more or less equal, chartaceous, minutely scabrid or glaucous, 22–50 mm long, 5(–7)-nerved; *lemma body* cartilaginous, apically pubescent, basally glabrous, 5–8 mm long, 9–11-nerved, nerves anastomosing into awn base and 9–15 mm long lateral bristle; *lemma lobes* 1.5–3.5 mm long, acute to acuminate, partly to fully adnate to bristles; *central awn* geniculate, scabrid, contorted basally, 5.5–11.0 mm long from base to knee, 11–18 mm long from knee to tip; *palea* longer than lemma body, bifid at apex. *Lodicules* two, glabrous or sparsely ciliolate. *Stamens* three, 5.0–7.5 mm long. *Ovary* glabrous, with apical pseudostigmata, styles short to absent. *Fruit* 4.5–6.0 mm long. Flowering time August to September. The distribution of this species is shown in Figure 3C.

Conert (1971) combined *Pentameris macrantha* Nees and *Danthonia macrantha* Schrad. The Hesse s.n. specimen on which Schrader (1824) based his original description of *Danthonia macrantha* has not been traced, and it is not known if this specimen was seen by Conert (1971). A neotype is designated here in its place.

The absence of a type specimen, and thus accurate floral measurement data, caused some problems in the allocation of the epithet *macrantha* to the relevant cluster in the PCA study. Despite the lack of the type specimen, Schrader's (1824) description includes the spikelet length, given as 1.5 inches (37.5 mm). As the glumes extend well beyond any floret parts except the awns, this spikelet measurement is interpreted to equate to that of the glumes. As this figure (37.5 mm) is close to the mean glume size

(37.14 mm) for one of the two clusters distinguished by the PCA, this cluster is allocated the epithet *macrantha* (Figure 1).

In contrast to the paucity of information provided by Schrader, Trinius (1827) provides an elegant description of this species, referring to an elongate woody rhizome and a branched culm. This description is accompanied by a detailed illustration showing a well-developed rhizome. These characters clearly match the morphology of the specimens in the rhizomatous cluster of the PCA, which Schrader's description implies represents *P. macrantha*. Unfortunately, although citing Schrader's description, Trinius does not provide a collector and number for the specimen on which his description or illustration is based, and mentions no type specimen. Therefore the link between his clear description and the Hesse specimen on which Schrader's description was based is tenuous at best.

The Trinius herbarium is presently housed at St Petersburg (Leningrad). The grass collection, including Trinius's types and the material on which his illustrations are based, have recently been databased (R. Soreng, Cornell University pers. comm). Computer records indicate that these include several specimens of *Danthonia macrantha*, although the type status of these is not certain. All attempts to communicate with this herbarium have failed, and thus the unsatisfactory solution of neotypification has been implemented. The second cluster in the PCA is considered to be a new species and is described below.

Vouchers: Adamson 1251 (BOL); Boucher 2661 (STE); Ellis 2308 (PRE); Morely 176 (STE); White 5518 (PRE).

4. *Pseudopentameris caespitosa* N.P. Barker sp. nov. a *P. macrantha* habitu caespitoso, culmis simplicibus, partibus floralibus grandioribus, glumis 33–60 mm longis, arista centrali lemmatis 27–45 mm longa differt.

Plants perennial with woody or fibrous basal underground parts, caespitose. *Stems* absent. *Culm* annual, 0.7–1.0 m long, sometimes decumbent. *Leaves*: sheaths basal, persistent, often purple, appressed to culm; sheath mouth somewhat auriculate; leaf blades 45–500 mm long, open and flat or rolled. *Inflorescence* panicle, lanceolate and contracted, upper culm and panicle branches purple. *Spikelets* 10–20, laterally compressed, 2-flowered, highly reduced third floret rarely present; *glumes* two, more or less equal, 33–60 mm long, 5–9-nerved, chartaceous, minutely scabrid or glaucous, dark purple when young; *lemma* body cartilaginous, apically pubescent, basally glabrous, 8–10 mm long, 9–11-nerved, nerves anastomosing into awn base and 15–30 mm long lateral bristle; *lemma lobes* 2–4 mm long, acute to acuminate, partly to fully adnate to bristles; *central awn* geniculate, scabrid, contorted basally, 10–18 mm long from base to knee, 17–27 mm long from knee to tip; *palea* longer than lemma body, bifid at apex. *Lodicules* two, glabrous or sparsely ciliate. *Stamens* three, up to 9 mm long. *Ovary* glabrous, with apical pseudostigmata, styles short to absent. *Fruit* 5–6 mm long. Flowering time October–November. The known distribution of this species is shown in Figure 3D.

TYPE.—Western Cape, 3419 (Caledon): Bredasdorp, (–DC), eastern corner of Farm Buffeljagt, 19-10-1987, Linder 4362 (BOL, holo.).

This species is characterised by both its larger floral structures and its caespitose, unbranched growth form, hence the specific epithet. The glumes, culms and panicle branches are often dark purple when young, turning a dark brown biscuit colour with age, in comparison to the pale yellow of the glumes of *P. macrantha*. Although occurring with *P. macrantha* in some localities (e.g. Cape Point Nature Reserve, where they have been observed growing within a metre of each other), *P. caespitosa* flowers substantially later than *P. macrantha*, thus precluding any possible hybridisation.

In addition to the morphological differences described above, certain differences in the leaf anatomy have also been observed. In a phenetic study on a limited number of anatomical samples, Barker (1990) noted that specimens of what was then named *P. macrantha* were separable into two groups on the basis of three anatomical characters. One of these groups corresponds to the taxon here named *P. macrantha* and has a leaf which is V-shaped in cross section, with narrow furrows between the ribs and prickles distributed over the exposed adaxial rib surface. The other group corresponds to *P. caespitosa* (described above) in which the leaf is U-shaped, the furrows are open and the prickles are restricted to the edges of the adaxial ribs.

Vouchers: N. Barker 24 (PRE); Boucher & Shepard 4821 (STE); Ellis 1171, 2515 (PRE); Esterhuysen 31747 (BOL).

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A note on *Combretum* subgenus *Combretum* section *Macrostigmatea* (Combretaceae)

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Keywords: *Combretum*, section *Macrostigmatea*, southern Africa, taxonomy

ABSTRACT

The history of *Combretum* section *Macrostigmatea*, its circumscription and its representation in the *Flora of southern Africa* region are provided. A specimen from northern Botswana, *Miller B/1199*, initially misidentified as *C. engleri*, is shown to be *C. kirkii*, the first record of this taxon in the FSA region. *Combretum mkuzense* is placed in synonymy in *C. zeyheri* section *Spathulipetala*.

UITTREKSEL

Die geskiedenis van *Combretum* seksie *Macrostigmatea* en die omskrywing en verteenwoordiging daarvan in die gebied van die *Flora van suidelike Afrika* word voorsien. Daar word aangetoon dat 'n eksemplaar uit noordelike Botswana, *Miller B/1199*, wat aanvanklik verkeerd as *C. engleri* geïdentifiseer is, *C. kirkii* is, die eerste rekord van hierdie takson in die FSA-gebied. *Combretum mkuzense* word in sinonimie in *C. zeyheri* seksie *Spathulipetala* geplaas.

INTRODUCTION

Section *Macrostigmatea* of *Combretum* was erected by Engler & Diels in 1899 to accommodate two taxa, *C. macrostigmateum* Engler & Diels (1899) and *C. kirkii* M.A. Lawson (1871). Both taxa have the distal part of the style expanded, markedly so in *C. schumannii*, less obviously so in *C. kirkii*. In habit and distribution these taxa differ, *C. schumannii* being a tree or shrub known from Kenya, Tanzania, Malawi, Zimbabwe and Mozambique, and *C. kirkii* a scandent shrub or liana known to occur only in the drainage basin of the Zambezi River system and hitherto recorded from Zambia, Zimbabwe, Malawi and Mozambique.

A third taxon, *C. engleri* Schinz (1901), a multistemmed virgate shrub, was described from northern Namibia. This entity has since been recorded in Angola, southwestern Zambia and northern Botswana, growing in substrata derived from Kalahari sands. Liben (1965) described a fourth member of the section, *C. gillettianum* from material collected by Glover in northern Zambia. Plants assigned to this taxon are small trees or shrubs which to date have been recorded from Zaïre, northern Zambia and Tanzania.

Of these four taxa, two, *C. schumannii* and *C. engleri*, (Figure 1A, B) have flowers with a glabrous nectariferous disc, whereas the flowers of *C. kirkii* and *C. gillettianum* (Figure 1C, D) have a pilose disc margin.

Exell (1970) recognized the four taxa enumerated above as constituting section *Macrostigmatea*, at the same

time expressing the opinion that *C. schumannii* and *C. engleri* might prove to be conspecific, a view shared by Wickens (1973). Subsequently Exell (1978) formally reduced *C. engleri* to conspecificity in *C. schumannii* on the basis that the flowers of both entities have a glabrous nectariferous disc with a very short (less than 1 mm) free margin, the fruit of both is glabrous except for peltate secretory scales and of similar dimensions, and the shrub habit is common to both.

DISCUSSION

Section *Macrostigmatea* in southern Africa

Since, of the four entities recognized as species in 1970, only one, *C. engleri*, has been recorded from the *Flora of southern Africa* (FSA) region, it was necessary to decide whether to follow Exell's (1978) treatment or to maintain *C. engleri* as a species. It was therefore necessary to examine flowering, fruiting and vegetative material of *C. engleri sensu lato* and of *C. schumannii sensu stricto*. Of the material labelled *C. engleri* borrowed from or seen *in situ* in southern African herbaria, only a single specimen, *Miller B/1199* from Serondela, Chobe District in northern Botswana, bore flowers. This specimen, described as a straggling shrub, was cited by Exell (1970) as *C. engleri* and by Exell (1978) as *C. schumannii*. When we dissected flowers we found them to have a pilose disc margin (Figure 1C), a character which immediately excluded the specimen from *C. engleri* and *C. schumannii*.

Examination of peltate secretory scales of the specimen (Figure 2A–C) showed that these were structurally similar to those described (Stace 1969) for *C. kirkii* and different from those of a specimen of *C. engleri*, *Maguire 1597*, collected in the Caprivi Strip (Figure 3A). Subsequent examination of peltate secretory scales from type material of *C. kirkii*, *Kirk s.n.* (Figure 2D) and *Menyharth s.n.*,

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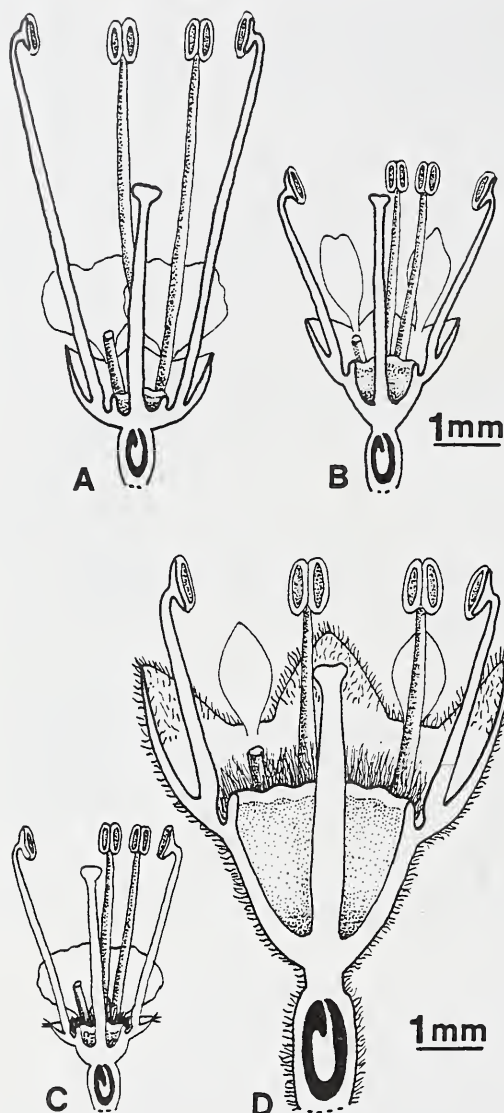


FIGURE 1.—Half-flower drawings, $\times 10$: A, *Combretum schumannii*, Burt 3826; B, *C. engleri*, Gossweiler 3241; C, *C. kirkii*, Miller B1199; D, *C. gillettianum*, Brenan 8172.

confirmed that, despite its smaller than average flowers, the depauperate specimen Miller B/1199 should be assigned to *C. kirkii* M.A. Lawson. The locality from which it was collected, which lies within the drainage basin of the Zambezi River system, and the straggling shrubby habit are appropriate for this species. This taxon has not previously been recorded from the FSA region. It is imperative to note that without examination of flowers and fruit and, in particular, without microscopic examination of peltate secretory scales at magnification of at least $400\times$, it is all too easy to fail to recognize the shrubby form of *C. kirkii*. The peltate secretory scales of *C. gillettianum* (Figure 2E–G) are less divided and mostly smaller than those of *C. kirkii*.

All other specimens labelled *C. engleri* from the FSA region, all described as shrubs, lacked flowers. Some bore

fruit, some were sterile, but the peltate secretory scales of all which were examined microscopically were structurally alike and it was therefore concluded that all were representatives of a single taxon. Specimens of *C. engleri*, among them Gossweiler 3241 (holotype of *C. chlorocarpum* Exell) and Exell & Mendonça 1325 were examined and found to have scales of the same kind (Figure 2J–M) as those of specimens labelled *C. engleri* from the FSA region (Figure 3A).

Exsiccata of *C. schumannii* collected in Tanzania and Malawi, including an isotype, Holst 2375, were examined at K and BM. The material of *C. schumannii* and *C. engleri* was compared (Table 1).

Carr (1988) made the significant point that whereas *C. schumannii* has been successfully propagated from seed in cultivation, all attempts to germinate seed of *C. engleri* in cultivation to date have failed. All these observations, together with the fact that as far as one can tell from existing records there is no overlap in the distribution ranges of *C. schumannii* and *C. engleri*, lead to the conclusion that these taxa are not conspecific and therefore the name *C. engleri* should be retained, at least until such time as germination tests have been carried out on material from Mozambique which is reported to be intermediate between *C. schumannii* and *C. engleri*.

The status of *C. mkuzense* J.D. Carr & Retief

The reasons for the establishment of *C. mkuzense* as a discrete taxon and for its placement in section *Macrostigmataea* (Carr & Retief 1989) are unclear since the type material, Carr 187 (PRE), is patently a specimen of *C. zeyheri* Sond. (section *Spathulipetala*). Carr & Retief (1989) state that the peltate epidermal scales of *C. mkuzense* agree well with those of other representatives of section *Macrostigmataea*. They fail to mention that the scales of *C. mkuzense* and those of *C. zeyheri* are structurally identical (Figure 3B, C; Table 2), yet they note that *C. zeyheri* is present in the area where the specimen Carr 187 was collected and that the fruit of *C. zeyheri* and that of *C. mkuzense* are alike. They do, however, point out that *C. zeyheri* is a small to medium-sized tree, whereas *C. mkuzense* is a scrambling shrub. Carr & Retief in referring to analyses by Rogers of triterpenoid and flavonoid-type compounds of local *Combretum* spp. (Carr & Rogers 1987) state that 'examination of the profiles of *C. mkuzense* and *C. kirkii* shows similarities but no significant difference', yet there is no mention in Carr & Rogers's (1987) paper of *C. kirkii*! They fail to point out that in the same paper Rogers records that the leaves of *C. mkuzense* and *C. zeyheri* contain exactly the same triterpenoids and flavonoid-type compounds in the same relative concentrations. Based on these comments and on analysis of selected, taxonomically important characters performed by the second author (Table 2), we conclude that *C. mkuzense* cannot be maintained as a discrete taxon, but must be reduced to synonymy in *C. zeyheri* Sond.

Combretum Loebl. subgenus **Combretum** section **Macrostigmataea** Engl. & Diels in Engl., Monographien afrikanischer Pflanzenfamilien und Gattungen 3: 24 (1899); Stace: 158 (1969); Exell: 176 (1970); Wiekens: 21 (1973); Exell: 115 (1978); Stace: 336 (1981). Lectotype: *Combretum*

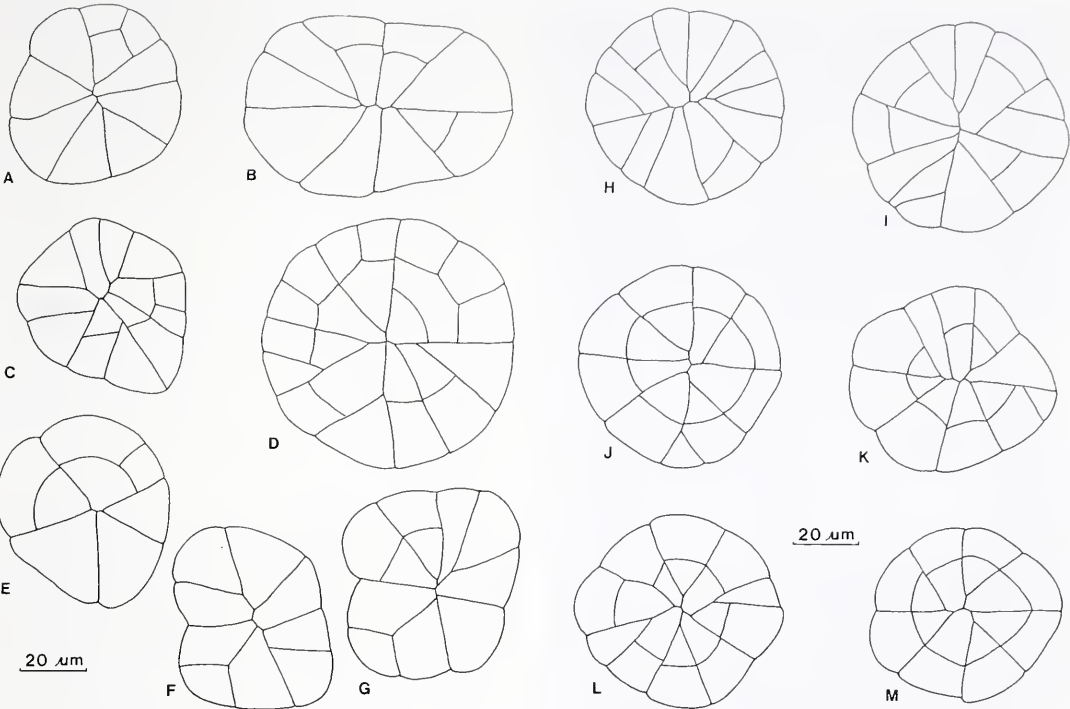


FIGURE 2.—Peltate secretory scale heads. A–D, *Combretum kirkii*: A–C, Miller B/1199; D, Kirk s.n., E–G, *C. gillettianum*, Hutchinson & Gillett 3956; H, I, *C. schumannii*, Burt 3940. J–M, *C. engleri*: J, K, Gossweiler 3241; L, M, Exell & Mendonça 1325.

macrostigmaeum Engl. & Diels = *C. schumannii* Engl., designated by Stace (1981).

1—several secondary and partial radial walls and several tangential walls to form 1–2(–3) concentric zones of cells.

Small tree, shrub, scandent shrub or liana. *Inflorescence* an elongate, subcapitate or capitate spike. *Flowers* tetramerous; *hypanthial tube* cupuliform or broadly infundibuliform, broader than long; *petals* ovate to subcircular with entire or emarginate apex, glabrous; *stamens* 8, insertion uniseriate near rim of nectariferous disc; *disc* concealed within hypanthial tube, the narrow free rim glabrous or pilose; *style* expanded (markedly or slightly) at apex. *Fruit* samaroid, medium-sized to large, 22–55 × 21–50 mm with 4 thinly chartaceous wings and slender stipe 7–30 mm long; *germination* epigeal with cotyledons arising above soil level (where known); *mature peltate secretory scale-heads* (35–) 45–85 μm in diameter divided by 8 primary radial walls,

CONCLUSIONS

Two species of *Combretum* subgenus *Combretum* section *Macrostigmaea* are currently recorded in the FSA region, *C. engleri* Schinz (which is maintained as distinct from *C. schumannii* Engl.) and *C. kirkii* M.A. Lawson which is recorded in this region for the first time. The entity described by Carr & Retief (1987), *C. nkuzense*, is shown to be neither a discrete species nor a member of section *Macrostigmaea*, but a misidentified specimen of *C. zeyheri* Sond., section *Spathulipetala*.

TABLE 1.—A comparison of taxonomically important characters of *Combretum schumannii* and *C. engleri*

	<i>C. schumannii</i>	<i>C. engleri</i>
Habit	tree	shrub
Mature leaf size	75–110 × 33–45	18–40 × 18 mm
Mature fruit size	30–34 × 27–31	22–32 × 21–30 mm
Hypanthial tube shape	cupuliform (Figure 1A)	broadly infundibuliform (Figure 1B)
Sepal indumentum	glabrous	apex ciliate
Petal proportions	as broad as long	longer than broad
Style apex	greatly expanded	slightly expanded
Secretory scales:		
diameter	62–68 μm	60–65 μm
no. of cells	± 16	± 16–18
no. of radial walls	± 12–13	± 8–10
no. of tangential walls	± 1–4 (Figure 2H, I)	± 7–8 (Figure 2J–M)

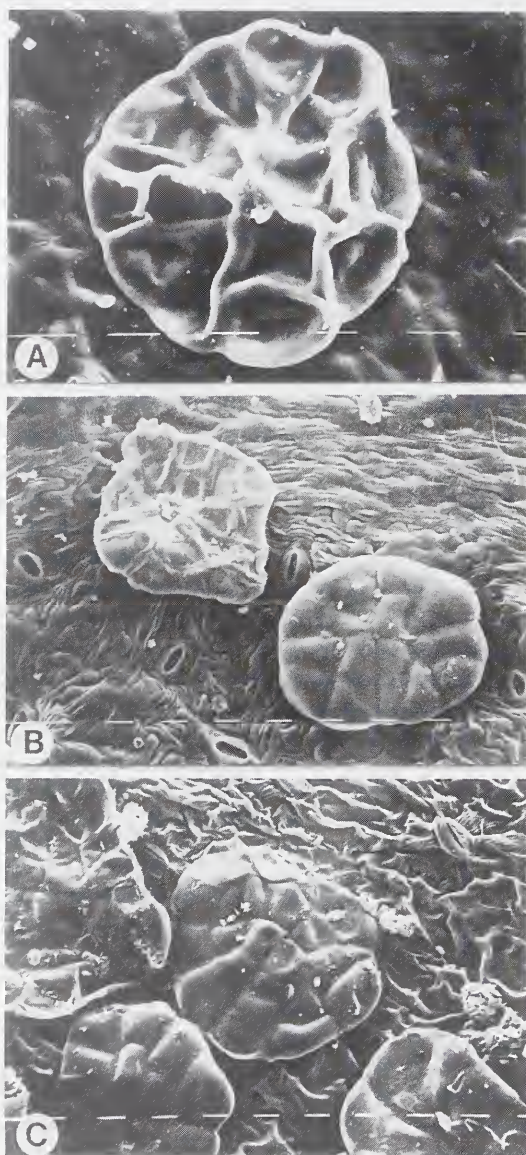


FIGURE 3.—Peltate secretory scales on abaxial surface of lamina. A, *Combretum engleri*, Maguire 1597; B, *C. mkuense* (synonym of *C. zeyheri*), Carr 187; C, *C. zeyheri*, Ward 3165. Scale bars: 10 μ m.

SPECIMENS EXAMINED

Combretum schumannii

TANZANIA.—0438. Lushoto Dist., Simbili, Holst 2375 (K, iso!). 0636: Mpwapwa (flowering material), Hornby 311 (BM). Grid ref. unknown, flowering material. Burti 3826, 3940 (BM).

MALAWI.—1435: Fort Johnston, Burti 5986 (BM, K).

C. gillettianum

ZAMBIA.—0831 (Abercorn Dist.): 1.6 km E of Mpulungu, Angus 773A (BM); flowering material, Brenan & Greenway sub Brenan 8172 (K); Mpulungu, Hutchinson & Gillett 3956 (K); flowering material, Richards 18416 (K).

C. kirkii

MOZAMBIQUE.—Grid ref. unknown: 14°–19°S, Tete, Kirk s.n. (K, holo.!), Sambesi, Boroma (Chnore), Menyharth s.n. (K, fragment of holo.!), of *C. menyhartii* Engl. & Diels).

ZIMBABWE.—1628: Kariba, Goldsmith 23/59 (BM, K).

BOTSWANA.—1824 (Kachikau): Serondela, Chobe Dist., flowering material, Miller B/1199 (PRE).

C. engleri

ANGOLA.—Northeastern region, Lunda Province: Biula, Chicoso R., Exell & Mendonça 1325 (BM); R. Coxii, Exell & Mendonça 1362 (BM). Southern region, Huila Province: Baixo Cunene, Rocadas, ao km 200 da estrada Sa da Bandeira-Rocadas, Borges 287 (BM, K); Distrito da Huila Rocadas, Centro de Estudos do Cunene, Da Silva 2943 (K); Gambos, Chibemba no Tchimbololelo, Meneses 569 (K); Mucope, desta para Bicular, flowering material, Meneses 3472 (K). Cuando Cubango Province: between Kuiri and Kuito, flowering material, Gossweiler 3241 (BM, holo.!), of *C. chlorocarpum* Exell).

NAMIBIA.—1714 (Ruacana Falls): 8 Meilen südlich Otjehua, Kaokoveld, (–CA), Giess & Leipert 7581a (NBG). 1715 (Ondangwa): bordering Angola near Oshikango, Ovamboland, about 32 miles (51.2 km) east at Eenhana, (–BD), Rodin 2669 (K). 1716 (Eenhana): south of airstrip at Eenhana, (–AD), Roux 151 (NBG); Amboland, Ombalambue, Ondonga, (–CA), Rautanen 236 (BM, photo.!), of holo. ex Z). 1719 (Rundu). Runtu, near Okavango River, Okavango Native Reserve, (–DD), Maguire 1597 (NBG). 1721 (Mbambi): Kavango, 2 km W of Mbambi, (–CC), Mueller & Giess 585 (K). 1723 (Singalamwe): Wes Caprivi, Olifantkamp, (–CD), Pienaar & Vahrmeijer 483 (K). 1820 (Tarikora): Okavango Native Territory, 15 m (24 km) W of Nyangana on road to Runtu, (–BA), De Winter & Marais 4589 (K). 1821 (Andara): Okavango Native Territory, 14.8 m (23.7 km) E of Nyangana Mission Station, (–AA), De Winter & Marais 4778 (K); Okavango Native Territory, Andara Mission Station, (–AB), De Winter 4242 (K); Grootfontein-Nord/Caprivi-zipfel, an der Pad von Andara nach Bagani, (–AB/BA), Merconueller & Giess 2002 (BM). 1918 (Grootfontein): Neitsas, Dünen, (–BC), Dinter 668 (BM, fragment of syn.!), of *C. myrtillofolium* Engl.). Neitsas, Dünen, Dinter 7278 (BM, isosyn.!). Hereroland, Otjituuo Reserve 236, 4 km S of Otjituuo depot in Omatako Omuramba, (–DA), D. Edwards 04398 (K). 2120 (Rietfontein): Hereroland, Epukiro Go 329 Reserve, 10 km S of Rooiboklaagte Omuramba along red line fence, (–AA), D. Edwards 04416 (K).

BOTSWANA.—1821 (Andara): Ngamiland, 25 km NE of Tsodilo Hill, (–DA/DB), Mueller & Biegel 2299 (K); northern base of second highest of Tsodilo Hills, Mueller & Biegel 2322 (K); slopes of Mount Female, Tsodilo Hills, Ngamiland, (–DB), Banks 31 (PRE). 1822 (Kangara): near Samogoma lediba, flowering material, (–CD), P.A. Smith 2864 (K). 1823 (Siambisso): 'rhino thicket' near Xauna Pan, (–AA), P.A. Smith 322 (K). 1920 (Tsumkwe): 38 km north of Aha Hills, (–DB), Wild & Drummond 6986 (K). 2022 (Lake Ngami): 28 m (44.8 km) W of Mabele Pudi Hills, (–CD), Blair Rains & Yalala 10 (K); Mabelepudi Hills, (–CD), Story 5093 (K).

C. zeyheri

NORTH-WEST.—2527 (Rustenburg): 'Macalisberg', (–DA/DB), Zeyher 552 (SAM, iso!).

KWAZULU-NATAL.—2632 (Bela Vista): Ndumu Hill, Ndumu Game Reserve, (–CD), Pooley 479 (NU); Mkonyane, Ndumu Game Reserve, Pooley 676 (NH). 2732 (Ubombo): Ingwavuma Hills, (–AA), Sirey 8170 (NH); 4 m (6.4 km) south of Ingwavuma, Ward 2048 (NH); Ingwavuma Dist., Ward 3165 (NH); Ingwavuma, (–AC), Ward 5661 (NH, UDW); Mkuze Game Reserve, African staff quarters area, (–CA), Carr 187 (PRE, holo.!), of *C. mkuense* Carr & Retief); Mkuze Game Reserve, Msinga Sand Forest, White 10388 (PRE); Mkuze Game Reserve, (–CA/CB), Ward 3568 (PRE); east side of farm, 'Shotton 13810', (–CD), Ward 8793 (PRE).

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TABLE 2.—A comparison of taxonomically important characters of *Combretum zeyheri* and *C. mkuense*. Only personally observed characters have been used in table construction

	<i>C. zeyheri</i>	<i>C. mkuense</i>
Inflorescence type	elongated spike	elongated spike
Upper hypanthium shape	campanulate	campanulate
Sepals	ciliate	ciliate
Petals:	non-ciliate	non-ciliate
shape	spathulate (not broadly)	spathulate (not broadly)
distal margin	rounded, pointed, toothed or truncated	rounded, pointed, toothed or truncated
Stigma	slightly expanded	slightly expanded
Disc outer hairs	dense	dense
Scales:		
diameter	60–80 µm	60–90 µm
no. of cells	± 15	± 16
no. of radial walls	± 9	± 10
no. of tangential walls	± 15	± 15–18
outline	smooth or slightly scalloped	smooth or slightly scalloped
Fruit:		
length	exceeding 35 mm	exceeding 35 mm
wing and body hair distribution	sparse	sparse

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New records and new species of Asclepiadaceae from Namibia

P.V. BRUYNS*

Keywords: Asclepiadaceae, Namibia, new records, new species, taxonomy

ABSTRACT

Eleven species of Asclepiadaceae not previously recorded from Namibia are discussed. Of these, *Brachystelma codonanthum* Bruyns, *B. recurvatum* Bruyns and *Schizoglossum saccatum* Bruyns are new species. The new combinations *Brachystelma gymnopodium* (Schltr.) Bruyns (for *Ceropegia pygmaea* Schinz) and *B. schultzei* (Schltr.) Bruyns [for *Tenaris schultzei* (Schltr.) E. Phillips] are proposed and the delimitation of *Brachystelma* R. Br. against *Ceropegia* L. and *Tenaris* E. Mey. is discussed. Notes are also included on little-known species, and the species of *Gomphocarpus* R. Br. in Namibia are enumerated.

UITTREKSEL

Elf spesies van die Asclepiadaceae wat nog nie voorheen in Namibia aangeteken is nie, word bespreek. Hiervan is *Brachystelma codonanthum* Bruyns, *B. recurvatum* Bruyns en *Schizoglossum saccatum* Bruyns nuwe spesies. Die nuwe kombinasies *Brachystelma gymnopodium* (Schltr.) Bruyns (vir *Ceropegia pygmaea* Schinz) en *B. schultzei* (Schltr.) Bruyns [vir *Tenaris schultzei* (Schltr.) E. Phillips] word voorgestel en die omgrensing van *Brachystelma* R. Br. teenoor *Ceropegia* L. en *Tenaris* E. Mey. word bespreek. Notas oor min bekende spesies word ook ingesluit en die spesies van *Gomphocarpus* R. Br. in Namibia word opgenoem.

INTRODUCTION

Several collecting trips to Namibia since 1987 have brought to light species of Asclepiadaceae not previously recorded from Namibia. Searches through the material preserved in the National Herbarium, Windhoek (WIND) have also revealed a few already recorded but not dealt with in Huber (1967).

The recently published list of Namibian plants (Kolberg *et al.* 1992) has various errors in the account of the Asclepiadaceae. Some of these are rectified here. Keys are provided to the taxa where possible. The very confused state of the taxonomy of the complex of genera around *Asclepias* does not allow for an exact statement as to the generic placing of all the species. This problem is being addressed by Nicholas (pers. comm. 1994) and once this has been sorted out it should be possible to construct keys to these genera. The genera are arranged alphabetically except for those in the *Schizoglossum* complex which are all discussed together.

1. ASCLEPIAS L.

Apart from the larger, shrubby species of *Asclepias*, which are here placed under *Gomphocarpus*, no others are listed by Huber (1967). However, at least two collections of small, herbaceous species are known from Namibia. Their identification poses somewhat of a problem as generally species of the narrow-leaved, herbaceous type in *Asclepias*, as with *Pachycarpus* E. Mey., are known from the eastern side of southern Africa only (Nicholas

1982: 450). Since the genus *Asclepias* is now intended to be restricted to the American species (see discussion under *Gomphocarpus*), these will all be moved to other genera in due course.

Key to the herbaceous species of *Asclepias* for Namibia

- 1a Leaves at least 3 mm broad at middle, plant branching profusely from base with spreading stems *A. randii*
- 1b Leaves not more than 1.5 mm broad at middle, plant usually single-stemmed, erect *A. aurea*

1.1 *Asclepias aurea* (Schltr.) Schltr.

A. aurea is widespread along the eastern side of southern Africa and also occurs in Zimbabwe (Brown 1902–1904). According to Nicholas (1982: 452), it does not occur in the Cape Province but I have seen plants undoubtedly belonging to this species south of Kuruman in the northern Cape (Bruyns 5836, BOL).

There is a small specimen in WIND which is probably also referable to *A. aurea*. However, whereas material from Kuruman fits the description of *A. aurea* exactly, in this Namibian collection there are some differences. It is slightly more hairy than *A. aurea* (where the leaves are glabrous except sometimes for a few hairs on the midrib beneath) and the peduncles are also much shorter. A brief description of this material follows.

Plant 100–250 mm tall, stems just over 1 mm thick, erect, with fine hairs in a single line, internodes 15–20 mm long. *Leaves* up to 70.0 × 1.1 mm, scantily hairy on both sides, ± sessile. *Peduncle* up to 20 mm long, finely hairy in a single line, bearing 4 flowers. *Pedicel* 10–12 mm long, very scantily hairy. *Corolla* about 8 mm diam., lobes with few hairs on dorsal surface. *Corona* lobes about

* Bolus Herbarium, University of Cape Town, Private Bag, Rondebosch 7700.
MS. received: 1994-12-02.

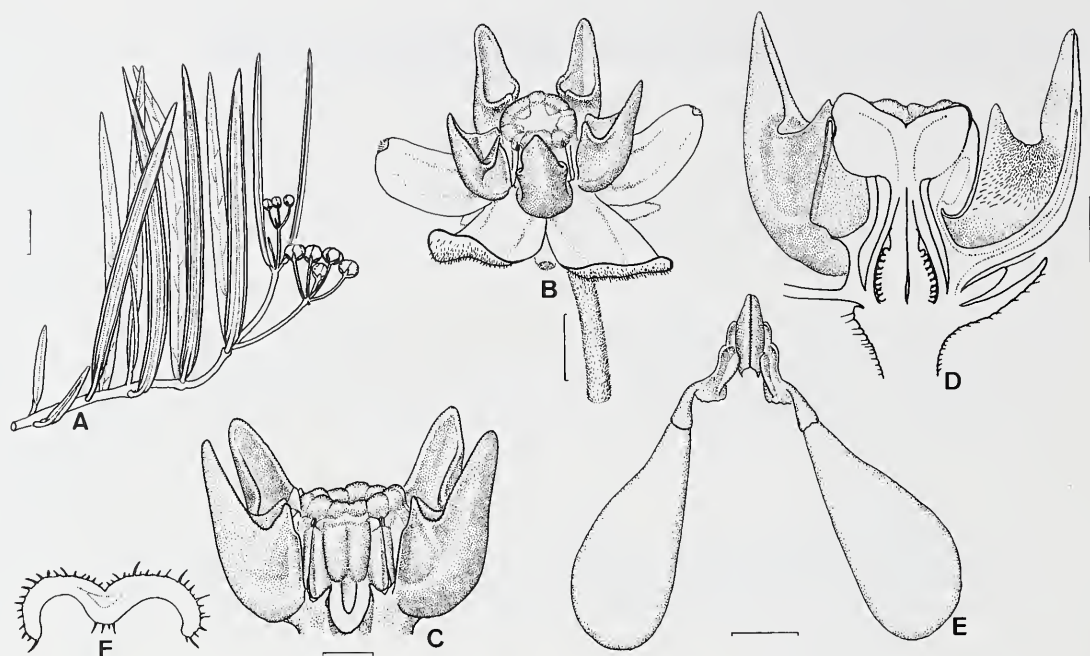


FIGURE 1.—*Asclepias randii*, Bruyns 5487. A, portion of plant; B, flower; C, gynostegium with one corona lobe removed; D, half flower, papillae on inner face of corona lobes clearly visible; E, pollinarium; F, cross-section of leaf, taken near middle. Scale bars: A, 10 mm; B, 2 mm; C, F, 1 mm; D, 1 mm; E, 0.25 mm.

2.5 mm long, with many papillae inside hood. Otherwise as in *A. aurea*.

Specimen examined

NAMIBIA.—2217 (Windhoek): near Windhoek, (–CA), Seydel 4109, coll. Jan. 1965 (WIND).

1.2 *Asclepias randii* S. Moore. Figure 1.

Small herbs belonging probably to this species were observed among short grasses on a gentle slope in the Otavi Mountains. According to Brown (1902–1904: 351), *A. randii* is known only from central Zimbabwe. However, the species is very similar to *A. modesta* N.E. Br. (Nicholas pers. comm. 1994) which is known to be widespread in south tropical Africa with known localities in Tanzania, Zambia, Malawi and Angola (Brown 1902–1904). The two seem to be separated mainly by the rather long, erect apices of the corona lobes in *A. randii*, which project somewhat above the gynostegium.

A. modesta was made a synonym of *Trachycalymina pulchellum* (Decne.) Bullock (1953: 351), a genus which Bullock defined mainly by the papillae or 'papilliform hairs' on the inner face of the hood formed by the corona. These papillae are present in both the material illustrated here of *A. randii* (Figure 1D) and *A. aurea* but neither appears to have been referred to *Trachycalymina* Bullock.

Specimen examined

NAMIBIA.—1917 (Tsumeb): Otavi Mountains, (–DB), Bruyns 5487 (BOL.; K, alcohol only).

2. BRACHYSTELMA Sims

Two new species of *Brachystelma* are described. The generic boundaries of *Brachystelma* against *Ceropegia* and *Tenaris* E. Mey. are discussed and this results in two new combinations in *Brachystelma*. A key to these genera and *Macropetalum* Burch. is given and also one to all the species of *Brachystelma* in Namibia.

2.1 *Brachystelma recurvatum* Bruyns sp. nov., a ceteris speciebus lobis corollae pedicellisque longissimis angustissimis differt. Typus: Namibia, 1917 (Tsumeb): Otavi Mountains, (–DB), 5-2-1993, Bruyns 5486 (BOL., holo.; WIND, K, iso.). Figures 2, 3.

Plant with flattened subglobose tuber up to 80 mm diam., with 1–several erect simple to branched stems reaching 60–300 mm tall. Stems 1–2 mm thick, pubescent,



FIGURE 2.—*Brachystelma recurvatum*, Bruyns 5486, showing very slender pedicels and recurved petals.

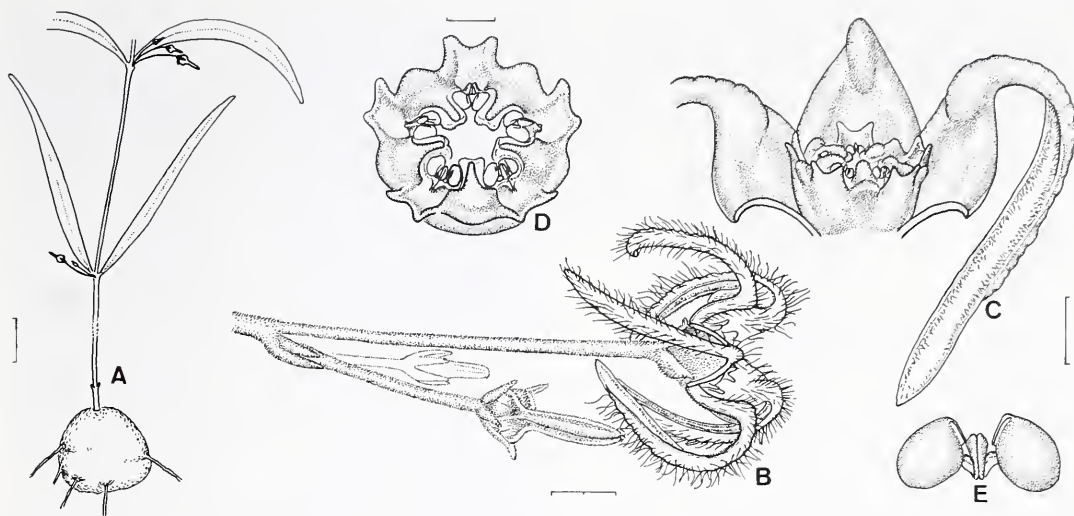


FIGURE 3.—*Brachystelma recurvatum*, Bruyns 5486. A, plant, much reduced in length (up to 300 mm tall); B, flower and bud; C, dissected flower; D, gynostegium; E, pollinarium. Scale bars: A, 10 mm; B, 2 mm; C, 1 mm; D, 0.5 mm; E, 0.25 mm (at B).

green to purplish. *Leaves* 30–90 × 3–13 mm, narrowly lanceolate, margins recurved, pubescent on both surfaces, green, petiole 1.0–1.5 mm long. *Inflorescence* extra-axillary, bearing 1–4 successively developing flowers, pubescent; *peduncle* 0–2 × 0.5 mm; *pedicels* 10–16 × 0.25 mm, purplish. *Corolla* 7–8 mm diam., outside green finely pubescent, inside with fine crinkled white hairs, with very shallow tube (± 0.5 mm deep) enclosing base of gynostegium; *lobes* within greenish black blotched with very pale yellow (nearly colourless), with $\pm$ deltoid basal portion about 1.5 mm broad at base then abruptly narrowing into recurved tail $\pm 6 \times 0.5$ mm (seen in bud as long beak), margins recurved. *Gynostegium* ± 1.5 mm diam., glabrous; *outer corona lobes* truncate-bifid, pale yellow with large greenish black patch on inner surface; *inner lobes* with dorsal projection confluent with outer lobes and narrow limb incumbent on anthers nearly equalling them, with droplets of colourless fluid secreted on backs, practically colourless (pale yellow).

Brachystelma recurvatum is unlike any other species known in Namibia, with exceptionally slender pedicels and corolla lobes. The corolla lobes are strongly recurved behind the corolla with the narrow tail then sometimes bent back and partly obscuring the gynostegium, hence the epithet *recurvatum*. The corona structure is typical of the genus with short, truncate-bifid outer corona lobes and very small inner lobes. Plants were found among short grasses on a gentle slope between dolomite outcrops growing in reddish loam. This is the '*Tenaris spec. indet.*' mentioned and illustrated rather poorly in Bruyns (1984) from a specimen collected west of Outjo (no material preserved). Since there seems to be some vagueness about the distinctions between *Tenaris* and *Brachystelma*, this is discussed separately under 2.4 and 2.5.

2.2 *Brachystelma codonantherum* Bruyns sp. nov.
a *B. dinteri* Schltr. cognatum sed flore campanulato coronaque exteriore cupulata, a *B. cupulato* R.A. Dyer lobis

corollae deltoideis et corona exteriore quinqueloba discedit. Typus: Namibia, 1918 (Grootfontein): northeast of Grootfontein, (–BB), Bruyns 5518 (BOL). Figure 4.

Plant arising from a depressed-globose tuber up to 20 × 30 mm. *Stem* usually solitary, simple, $\pm$ erect, 20–150 × ± 1.5 mm. *Leaves* 11–22 × 9–15 mm, elliptic, tapering into petiole 1–2 mm long. *Flowers* in small sessile groups extra-axillary at nodes, opening successively. *Pedicel* spreading, 2–3 × 0.5 mm. *Sepals* lanceolate, acute, 2 × 0.5 mm. *Corolla* 5 × 9–10 mm, outside pale green to brown, inside glabrous obscurely transversely rugose green to brown with greenish tips, campanulate; *tube* $\pm 2.5 \times 4.0$ mm (across mouth), broadly conical; *lobes* 3–4 × 3 mm, deltoid, spreading. *Gynostegium* 1.5 × nearly 3.0 mm, dark brown, glabrous, cupular; *outer corona lobes* rising above rim of cup, bifid, narrowing towards apex; *inner lobes* cushion-like, arising lower down in cup and adpressed to backs of anthers near their base, very short and usually leaving most of anthers uncovered.

Specimens examined

NAMIBIA.—1819 (Karakuwisa): (–CC), Bruyns 5990 (BOL). 1918 (Grootfontein): (–BB), Bruyns 5518 (BOL).

With its solitary, erect stem and elliptical leaves, this species resembles *B. dinteri* vegetatively and, when collected, was assumed to be that species. On flowering, it turned out to have a completely different, campanulate flower with somewhat cupular corona. In *B. dinteri* the outer corona lobes arise between the broad dorsal parts of the inner lobes which determine the pentagonal shape of the corona. In *B. codonantherum* the inner corona lobes arise on the inside of the cupular outer corona as in *B. cupulatum*. From *B. cupulatum* it is distinguished by differently-shaped corolla lobes with rugose surface (oblong in *B. cupulatum*, deltoid in *B. codonantherum*) and the outer corona cup which is deeply 5-lobed in *B. codonantherum* and notched around the apex in *B. cupulatum*. *B. codonan-*

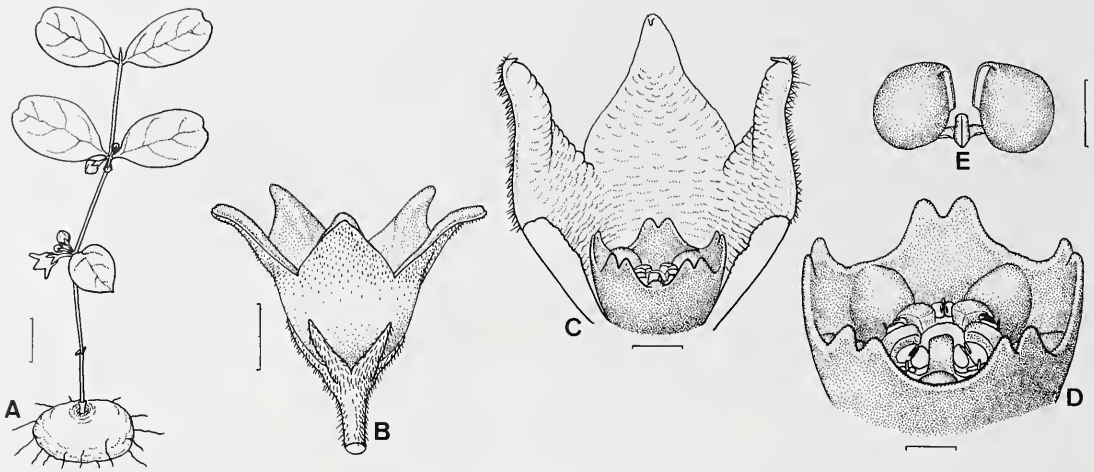


FIGURE 4.—*Brachystelma codonantherum*, Bruyns 5518. A, portion of plant; B, flower; C, dissected flower; D, gynostegium; E, pollinarium. Scale bars: A, 10 mm; B, 2 mm; C, 1 mm; D, 0.5 mm; E, 0.25 mm.

thum was found in two places northeast of Grootfontein growing in deep white sand in open forest.

2.3 *Brachystelma blepharantha* (Schltr.) H.E. Huber

This small species of *Brachystelma* was not dealt with in Bruyns (1984) but, alongside that account, Müller (1984) recorded its 'rediscovery' in 1983 after 70 years since Dinter's original collections in 1909 and 1910. Actually it had been collected long before this in 1968 by C. Grabow near Gobabis, but this and another collection by Woortman from north of Okahandja remained unidentified at WIND until recently.

More intensive collecting over southern Namibia has revealed that this species is widely distributed in the southern half of the country from Gobabis and Okahandja southwards to Helmeringhausen. In the southern parts it is the only known species of *Brachystelma* (Figure 5).

Unlike other species, *B. blepharantha* grows in arid places on pebbly or stony ground usually in the open or among short bushes (sometimes even among *Rhigozum trichotomum*). From Gobabis to Windhoek and southwards to Nauchas it was mainly seen in spots with a scanty cover of small bushes with the ground densely strewn with quartz and other small pebbles. Several times it was observed growing with *Lithops pseudotruncatella*. Around Helmeringhausen it was usually found on stony, north-facing mountain slopes.

The tuber of *B. blepharantha* is usually cylindrical to irregularly top-shaped (Figure 6A) or very occasionally flattened discoid. The largest seen was $\pm 80 \times 50$ mm and several up to 80 mm long and only 20–30 mm thick were found. This shape is unique in *Brachystelma*. It is often tightly wedged among stones and can be difficult to extract. In the northern part of the distribution, plants seen were rarely more than 50 mm tall above the soil with the branches spreading horizontally up to about 100 mm. Further south, the plant may be erect with stems up to 300

mm tall. The cylindrical stems are almost always finely mottled with purple and the small leaves are usually crinkled (as in the largest plant in Figure 6A).

Generally in this species the sepals are green to brownish, the corolla tube is white (sometimes lightly suffused with pink), the lobes are green (sometimes with purplish margin), the inner corolla lobes are green whereas the rest of the gynostegium is white. In the northern part of the range the corolla lobes vary from 2–4 mm long,

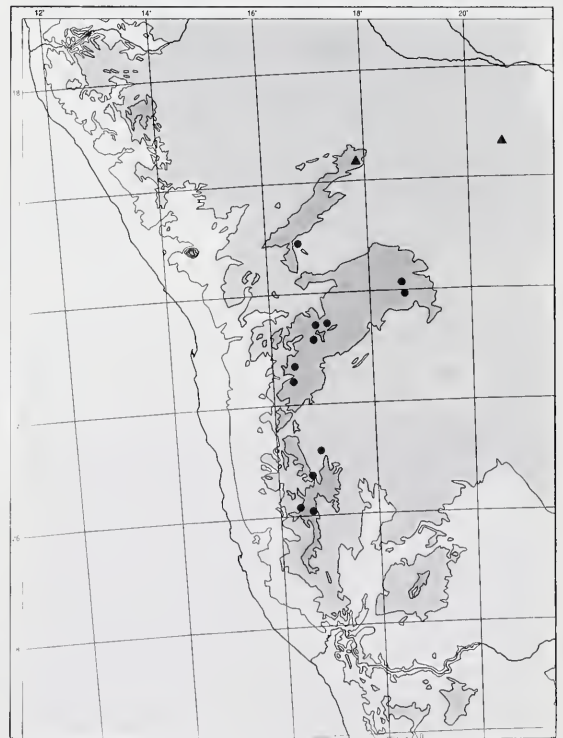


FIGURE 5.—Distribution of *Brachystelma blepharantha*, ●, and *Pachycarpus schweinfurthii*, ▲, in Namibia.



FIGURE 6.—A, B, *Brachystelma blepharantha*, Bruyns 5818: A, three plants excavated to show peculiar elongated tubers, usually crinkled leaves clearly visible in plant with largest tuber, B, plant with

the flowers are nodding (Figure 6B) and the club-shaped inner corona lobes are widely divergent to almost horizontally spreading. Towards the base the inner surface of the corolla lobe is usually covered with papillae each topped by a fine hair. Around Maltahohe plants were collected with flowers held erect and with the base of the corolla lobes entirely smooth within. Near Helmeringhausen the flower was nodding once more (Figure 7K), the corolla lobes were much longer (5 mm) and narrower, the papillae with hairs were again present but the corona lobes, though still club-shaped, were much less thickened towards their tips and were connivent rather than widely diverging (Figure 7L).

Specimens examined

NAMIBIA.—2116 (Okahandja): (–BA), Woortman 221 (WIND), 2118 (Steinhausen): (–DC), Grabow 19 (WIND), 2216 (Otjimbingwe): (–DB), Van Vuuren s.n. (WIND); (–DD), Bruyns 5626 (K), 2217 (Windhoek): (–CA), Van Vuuren s.n. (WIND), 2218 (Gobabis): (–BA), Bruyns 5818 (WIND), 2316 (Nauchas): (–AD), Pellemann 1334 (WIND); (–CB), Bruyns 5639 (BOL), 2416 (Maltahohe): (–DD), Bruyns 5658 (BOL), 2516 (Helmeringhausen): (–BC), Bruyns 5681 (BOL); (–CD), Bruyns 5703 (BOL); (–DC), Bruyns 5734 (BOL).

Brachystelma gymnopodium, a new name for *Ceropegia pygmaea* Schinz

The genera *Brachystelma* and *Ceropegia* have similar distributions around the perimeter of the Indian Ocean from southern Africa to Australia. The only recent regional treatments of both genera have covered southern Africa (Dyer 1980) and Australasia (Forster 1988; Bruyns & For-

ster 1989). None of these accounts deals with the problem of the boundaries between the two genera which is not as insignificant as this neglect may imply. Dyer (1980) followed Brown (1907–1909) in separating the two genera as follows:

- 1a Corolla tubular with the tube usually 2 to several times as long as its diameter at middle *Ceropegia*
- 1b Corolla opening nearly flat or tube campanulate, when tubular then less than twice as long as its diameter at middle *Brachystelma*

Many genera within the Stapelieae exhibit variation in the corolla from nearly rotate through campanulate to tubular (cf. *Stapelia leendertziae* N.E. Br., *Tridentea chonanthera* (Lavranos & Hall) L.C. Leach, *Echidnopsis mijerteina* Lavranos as extreme examples within their respective genera) and it is therefore not surprising to find this variation in *Brachystelma*. However, the tubular-flowered species of *Brachystelma* (such as *B. oianthum* Schltr.) may begin to resemble *Ceropegia* as it is defined above. Similarly some species may have been placed in *Ceropegia* because of this single character while their closest relatives are in *Brachystelma*.

The generic position of *Ceropegia pygmaea* is of concern here. It is clear from Brown (1902–1904), Huber (1957) and Dyer (1980) that *C. pygmaea* occupies an isolated position in *Ceropegia*, where its very long corolla tube places it according to the above definition.

In general the gynostegium of *Ceropegia* has a shallowly cupular outer corona with the usually bifid lobes only slightly overtopping the bases of the inner lobes. The dorsiventrally flattened inner lobes are incumbent on the backs of the anthers and then rise up, connivent, in a column above the centre of the style head. Whereas exactly this inner corona structure is found randomly in several genera, but is useful there only to separate species [cf. *Lavrania cactiformis* (Hook.) Bruyns and *L. picta* (N.E. Br.) Bruyns, (1993)], it is remarkably reliable in separating *Ceropegia* from its allies. As far as I am aware there are only three species out of about 160 where this is not found: *C. pygmaea* (southern Africa), *C. loranthiflora* K. Schum. (Ethiopia: own unpublished drawings of material at K) and *C. dorjei* C.E.C. Fisch. [Bhutan: illustrated in Huber (1957) but gynostegium possibly based on a juvenile flower].

The gynostegium in *Brachystelma* on the other hand, has an extremely variable outer corona: from slender bifid lobes to a tube containing the whole gynostegium. The inner corona lobes are invariably small and often only just touch the backs of the anthers near their base. In a few cases they exceed them, rising up connivent in a column above the style head as in *Ceropegia*: *B. blepharantha*, *B. dyeri* K. Balkwill, *B. gracile* E.A. Bruce, *B. pachypodium* R.A. Dyer and *B. schizoglossoides* (Schltr.) N.E. Br. are the only examples known to me. In all these the corolla tube is shorter than it is broad and so these species separate out (according to Dyer 1980) clearly as *Brachystelma*, where their closest relatives are as well.

In *Ceropegia pygmaea* the outer corona forms a deep cup hiding the rest of the gynostegium (Figure 8G, H). The inner corona lobes are short, touching the backs of the anthers and do not exceed them (Figure 8K). As can be seen, the corolla is very variable in length, ranging from twice its maximum breadth with the mouth up-turned (Figure 8B) to about five times its maximum breadth (Figures 8C; 9) with the mouth turned down towards the soil and usually touching it or even becoming slightly buried among leaf litter and loose sand [exactly as observed in *Echidnopsis ballyi* (Marn.-Lap.) P.R.O. Bally, (Bruyns 1988)].

In *C. pygmaea* the leaves vary from broadly ovate to linear. Narrow-leaved forms are difficult to distinguish when sterile from *Brachystelma stenophyllum* (Schltr.) R.A. Dyer and, in fact, vegetatively these two are very similar: both are small plants arising from a

flattened-globose tuber with short stems branched just above ground level, producing a cluster of leaves usually close to the ground with flowers developing on short, horizontal peduncles near the base of the stems. Their gynostegia are almost identical. A similar corona structure is also found in *B. cupulatum* and *B. brevipedicellatum* Turrill. These four species possibly form a group with corolla increasing in tubularity from the nearly rotate state in *B. brevipedicellatum* via *B. stenophyllum* (illustrated in Bruyns 1984) to the deep tube of *C. pygmaea*. Whereas *C. pygmaea* occupies an isolated position in *Ceropegia*, its close affinities to *B. stenophyllum* suggest that it would be much better accommodated in *Brachystelma* and it is therefore transferred to that genus. However, it cannot be called *Brachystelma pygmaeum* because of the earlier and validly published *Brachystelma pygmaeum* (Schltr.) N.E. Br. Therefore a new combination is required:

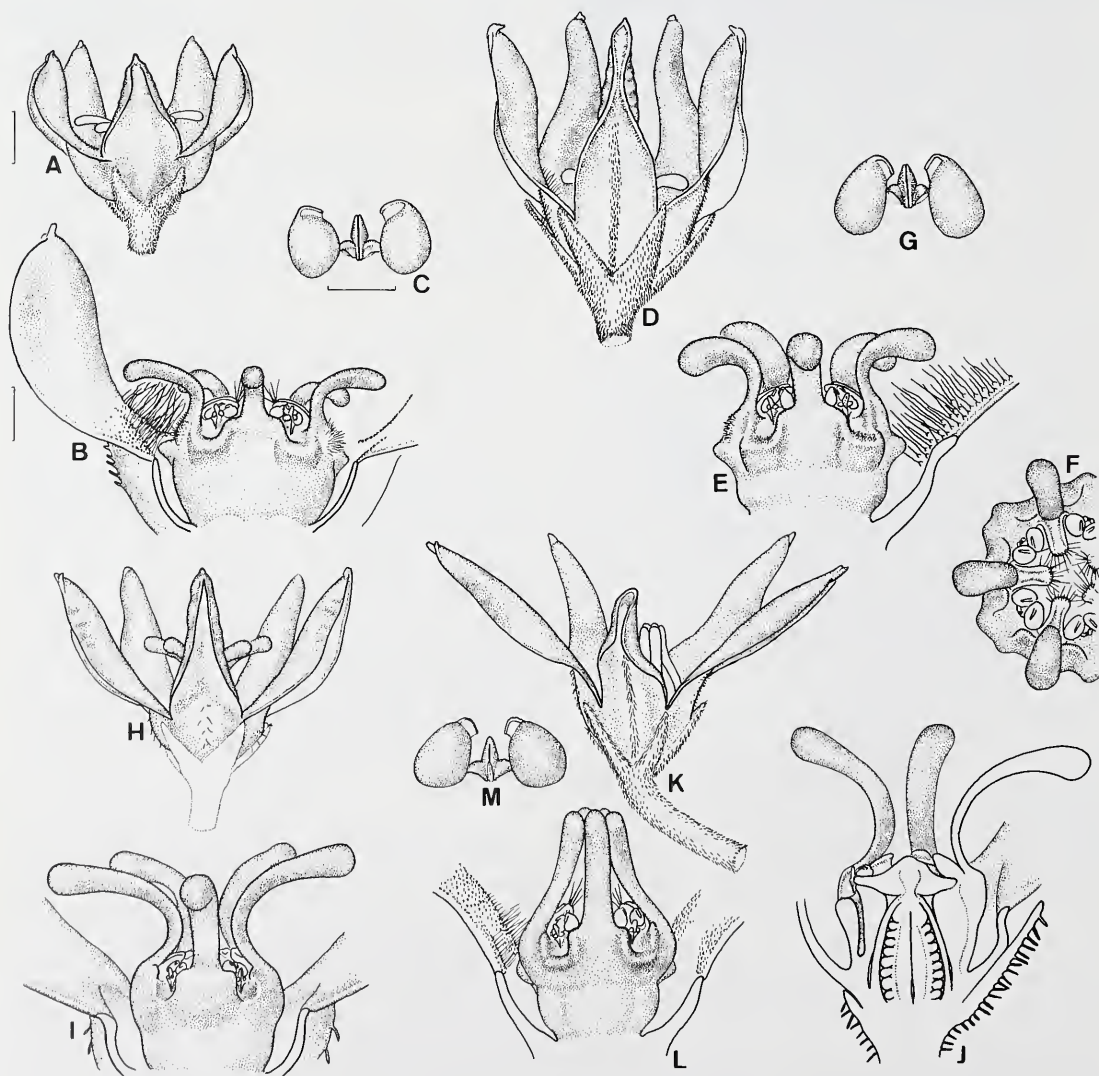


FIGURE 7.—*Brachystelma blepharantthera*. A, D, H, K, flowers; B, E, I, L, dissected flower showing gynostegium from side; F, face view of gynostegium; J, half flower; C, G, M, pollinaria. Scale bars: A, D, H, K, 1 mm (at A); B, E, F, I, J, L, 0.5 mm (at B); C, G, M, 0.25 mm (at C). A–C, Bruyns 5626; D–G, Bruyns 5639; H–J, Bruyns 5658; K–M, Bruyns 5703.

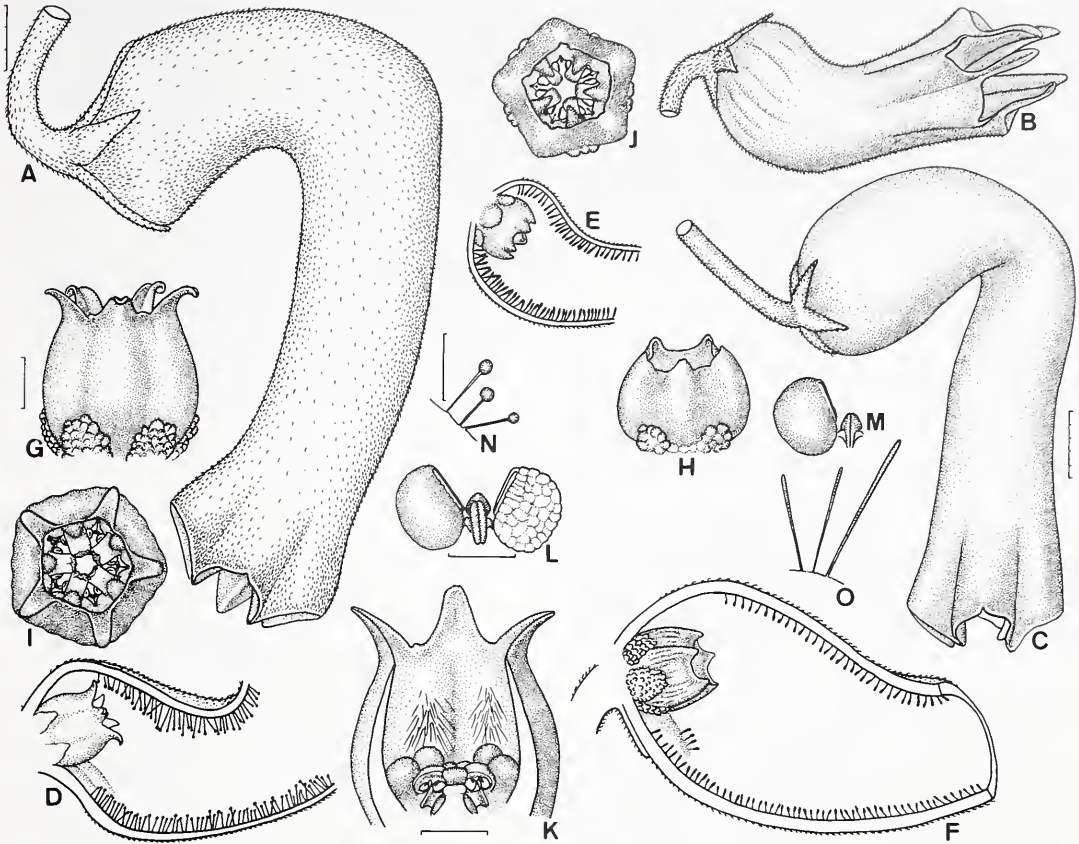


FIGURE 8.—*Brachystelma gymnopodum* (*Ceropegia pygmaea*). A–C, flowers; D–F, corolla dissected; G, H, side view of corona; I, J, face view of gynostegium; K, dissected gynostegium; L, M, pollinaria; N, O, hairs in corolla tube. Scale bars: A, B, D, E, F, 3 mm (at A); C, 5 mm; G, H, I, J, 1 mm (at G); K, 1 mm; L, M, 0.25 mm (at L); N, O, 0.5 mm (at N). Drawn from: A, D, G, I, K, L, N, Bruyns 2078, Gravelotte, eastern

2.4 *Brachystelma gymnopodum* (Schltr.) Bruyns, comb. nov. *Ceropegia gymnopoda* Schltr. in Bulletin de l'Herbier Boissier 4: 450 (1896). Type: Namibia, Rautanen 82 (Z).

Ceropegia pygmaea Schinz (1888). Type: Namibia, Schinz 147 (Z). Figures 8, 9.

***Tenaris* E. Mey. in Namibia? A new combination in *Brachystelma* for *Tenaris schultzei* (Schltr.) E. Phillips**

Brown (1902–1904) listed three species of *Tenaris* from tropical Africa (two from Somalia and one from Tanzania) and commented that 'there is little beyond habit to distinguish this genus from *Brachystelma*'. In the key he used the 'terminal raceme or lax panicle' of flowers to distinguish these species from *Brachystelma*. Brown (1907–1909) listed four species of *Tenaris* for South Africa. In this account he used characters of the flower 'corolla tube very short; lobes free, not reflexed' etc. to distinguish *Tenaris* from *Brachystelma* but it is not clear how this could succeed in separating these genera, for there are many species of *Brachystelma* to which this would apply equally well. It appears that *T. chlorantha* Schltr., where there is no 'terminal raceme or lax panicle',

may be the reason for Brown's abandoning his earlier distinctions for *Tenaris*.

The seven species listed in Brown (1902–1909) appear to share the following characteristics:

Flowering stems slender, erect, unbranched, glabrous; leaves linear 1–2 mm broad or filiform, blade narrower than midrib on flowering stems, glabrous; peduncle and



FIGURE 9.—*Brachystelma gymnopodum*, Bruyns 5512. Plant with broad leaves and very long corolla touching ground at anthesis.

pedicel glabrous; exterior of corolla glabrous; follicles glabrous. Some of these characters are found in species of *Brachystelma* but no *Brachystelma* has all of them.

Another species, *Tenaris schultzei* (Schltr.) E. Phillips was added in 1941. Here, although the plant often has only a single stem and linear leaves 1–2 mm broad, the stem may branch above and the flowers are not borne on long, slender, unbranched stems. The entire plant is pilose. Schlechter (1914) intended describing this species as a *Brachystelma* but decided, after a more thorough examination of the gynostegium, that the long, connivent inner corona lobes were more similar to those in *Ceropegia* than *Brachystelma*. However, the corolla was entirely different from *Ceropegia* and hence he placed it in a separate genus *Kinepetalum* Schltr. Phillips* (1941) placing of this species in *Tenaris* was not justified by any discussion and, indeed, if it is to be accepted, then it is unclear how *Tenaris* should be defined. Dyer (1975), partly following Brown (1907–1909), characterised *Tenaris* by 'Corolla tube almost obsolete, with linear, linear-spathulate or sometimes filiform lobes, slender erect herbs with tubers'. However, 'corolla tube almost obsolete' and 'slender erect herbs with tubers' would fit many species of *Brachystelma* and *T. schultzei* [as illustrated in Bruyns (1984)] would not fit comfortably into 'slender erect herbs'. Also 'linear' or 'filiform lobes' would fit some species of *Brachystelma* as well (e.g. *B. recurvatum*, *B. gracile*).

Schlechter was in favour of segregating many species from *Brachystelma* but most of his segregate genera were abandoned by Brown (1902–1904). Bullock (1953) seems to have intended reviving some of these segregates and started moving species to *Dichaelia*, but this was abandoned by Dyer (1980). If one is to make the treatment of this group consistent with that being applied in the Asclepiadeae, and elsewhere in the Stapelieae, then one will have to examine Bullock's statement (1953: 358) that *Brachystelma* is unsatisfactorily 'heterogeneous' in some detail. In my opinion Bullock's statement is not true except perhaps in respect of the inclusion within the genus of those species with fusiform roots. These species differ in their vegetative parts and florally quite substantially from the remainder of the genus. Also, *Dichaelia*, as Bullock envisaged it, is unsatisfactory and it would

be unwise to resurrect the genera *Siphonostelma* Schltr. and *Kinepetalum* which seem to be superfluous.

Nevertheless there appears to be a case for maintaining *Tenaris* as distinct from *Brachystelma* provided it is confined to the seven species of Brown (1902–1904; 1907–1909). *Brachystelma christianeae* Peckover (1992) also belongs to this genus. Furthermore, it needs to be considered carefully whether *Tenaris* should be united with the monotypic *Macropetalum* which also shares most of the above-mentioned characters. There seems to be no justification for placing *T. schultzei* in *Tenaris* and it should be moved to *Brachystelma*. This change is effected below.

2.5 *Brachystelma schultzei* (Schltr.) Bruyns comb. nov.

Kinepetalum schultzei Schltr. in Botanische Jahrbücher 51: 150 (1914). *Tenaris schultzei* (Schltr.) E. Phillips (1941). Lectotype: Namibia, Okakuja, Dinter 2528 (SAM).

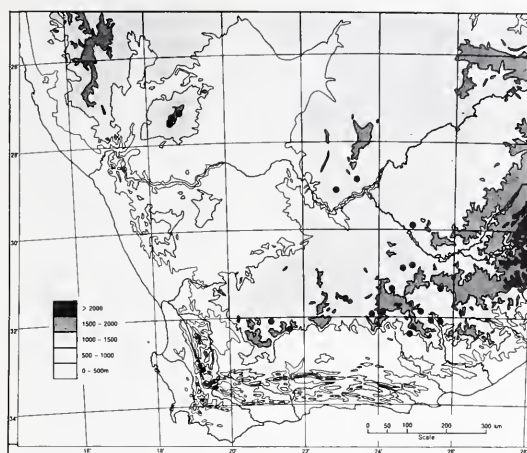
To summarise the information above, one may separate the four genera *Brachystelma*, *Ceropegia*, *Macropetalum* and *Tenaris* as follows:

- 1a Corolla rotate to campanulate, tube broader than long, if longer, then inner corona lobes not exceeding anthers:
 - 2a Flowering stems slender, unbranched glabrous; leaves linear or filiform, 1–2 mm broad, glabrous; exterior of corolla glabrous:
 - 3a Pedicel glabrous, anthers horizontal, pollinia inserted at level of top of style head *Tenaris*
 - 3b Pedicel pilose, anthers erect, pollinia inserted about half-way up style head *Macropetalum*
 - 2b Flowers amongst leaves on short often spreading, branched stems; stems pubescent; leaves pilose, usually with distinct blade narrowing into petiole and to apex; exterior of corolla pilose [at least one of these must apply, many species will not satisfy all of them] *Brachystelma*
- 1b Corolla with tube longer than max. breadth; inner corona lobes exceeding anthers, connivent into column above style head *Ceropegia*

The key to *Brachystelma* in Namibia in Bruyns (1984) is incomplete, dealing only with the five species discussed there. There are now 11 species recognised from Namibia and it is necessary to construct a key to them. This key is somewhat complicated, using characters of the corona as well as more obvious ones.

Key to *Brachystelma* spp. in Namibia

- 1a Outer corona lobes united above anthers into an entire to 5-lobed cup with inner lobes cushion-like fused to inside of cup $\pm$ half-way up:
 - 2a Corolla tube more than twice as long as lobes *B. gymnopodium*
 - 2b Corolla tube shorter than lobes:
 - 3a Corolla lobes ovate-lanceolate becoming linear above, fused at apices *B. stenophyllum*
 - 3b Corolla lobes deltoid to oblong, not becoming linear above, free at apices:
 - 4a Corolla lobes oblong 4.5–6.0 mm long, cup formed by outer corona with 5 small notches in margin *B. cupulatum*
 - 4b Corolla lobes deltoid 3–4 mm long, outer corona cup deeply 5-lobed with each lobe bifid and narrowing towards apex *B. codonanthum*
- 1b Outer and inner corona lobes not as above:
 - 5a Inner corona lobes much longer than anthers, rising up and connivent above style head or widely separating:
 - 6a Corolla lobes lanceolate-oblong to narrowly deltoid, 2–4 $\times$ as long as broad at base, inner corona lobes clavate *B. blepharanthra*
 - 6b Corolla lobes $\pm$ filiform, about 10 $\times$ as long as broad at base, inner corona lobes uniformly wide to tips *B. schultzei*
 - 5b Inner corona lobes shorter than anthers, not rising up above style head:
 - 7a Pedicel 10–35 mm long:
 - 8a Corolla rotate, lobes not recurved, with clavate cilia along margins *B. schinzii*
 - 8b Corolla with recurved lobes without cilia along margins:
 - 9a Corolla glabrous within, lobes 2–3 $\times$ 1 mm *B. amottii*
 - 9b Corolla pubescent within, lobes $\pm$ 7.5 $\times$ 1.5 mm *B. recurvatum*
 - 7b Pedicel 1–5 mm long:
 - 10a Corolla faintly rugose within, lobes $\pm$ deltoid (1.0–1.5 $\times$ as long as broad at base) *B. dinteri*
 - 10b Corolla smooth within, lobes linear to filiform (at least 4 $\times$ as long as broad at base) *B. circinatum*

FIGURE 10.—Distribution of *Ceropogia filiformis*.

3. CEROPEGIA L.

3.1 *Ceropogia filiformis* (Burch.) Schltr.

The collections cited below are the first known from Namibia and extend the known distribution of this species about 450 km to the west. There are no known localities from the intervening territory between these Namibian gatherings and that of William Burchell, who originally discovered it in 1812 between Kloof and Witwater, southwest of Griquatstad in the northern Cape. The distribution map (Figure 10) has been compiled from material seen in BOL, NBG, from PRECIS records, collections (2922 BB, 2824 CD) cited by Wilman (1946) and two collections in cultivation in Cape Town. From the map the extremely wide and scattered range is clear with the records from Namibia providing a remarkable case of vicariance. Most of the other known localities lie on the Great Karoo in the Cape from Richmond eastwards to Colesburg and south to Pearston and Somerset East with further unusual records in the southwest between Sutherland and Fraserburg. There is a single collection from the Orange Free State near Lückhoff. This distribution is unique in the genus (Bruyns 1985).

In January 1989, after good rains had fallen, several colonies of plants were found on the eastern side of the Great Karas Mountains. Plants were scrambling in the open among stones or climbing on *Rhigozum trichotomum* bushes on flat areas on the summit of mountains. On the western side (seen February 1993) they are also quite plentiful at higher levels and usually found climbing on *Rhigozum trichotomum*.

Specimens of *Ceropogia filiformis* are extremely inconspicuous. The plant usually consists of an unbranched, thin (about 1 mm thick) cylindrical stem (up to 0.8 m but usually 150–300 mm long) arising from a dense cluster of thick, spreading, whitish, fusiform roots. The leaves are narrow, linear-lanceolate. On the other hand the flowers, which are 50–60 mm long, are quite striking. Most of the exterior is greyish mottled with purple. The contrast on the lobes of white on the medial keel against the dull

purple remainder and striking, narrow, replicate, purple-black margin makes them easily visible. A peculiar feature of this deeply coloured margin, which has particularly large epidermal cells, is the secretion along its length of regularly spaced droplets of a clear liquid. The function of this liquid remains unknown. The inside of the basal inflation of the corolla is white with longitudinal green stripes on which rows of scattered green papillae are located. These stripes continue up into the constricted part of the tube without the papillae. There are no hairs at all inside the corolla tube (Figure 11).

The outer corona has unusual, thickened, brownish or purple-red apices. The rest of the corona is white to yellow-white, flecked with purple-red spots, quite densely on the inner corona lobes, sparsely on the outer lobes. The raised style-head projecting above the anthers (Figure 11L) is most unusual. This is known in a few *Brachystelma* species but not in any other *Ceropogia*.

C. filiformis is unusual among the species with fusiform roots, slender non-succulent stems and leaves in that the stems are cylindrical and not angled. Its affinities among the other southern African species remain unclear.

Specimens examined

NAMIBIA.—2718 (Grünau): Great Karas Mountains, (–BC), ± 1 650 m, *Bruyns* 5767 (WIND); (–BD), 1 600–1 700 m, *Bruyns* 3523 (BOL, WIND); (–DA), ± 1 600 m, *Bruyns* 5806 (WIND).

NORTHERN CAPE.—3123 (Victoria West): (–DD), *Tyson* 410 (BOL); (–CA), *Bruyns* 4230 (no specimen). 3124 (Hanover): (–AD), *Bruyns* 3275 (BOL); (–CC), *Meve* 347 (BOL). 3221 (Merweville): (–AA), *Bruyns* 4840 (BOL); (–BC), *Bruyns* 5969 (BOL).

EASTERN CAPE.—3125 (Steynsburg): (–CC), *Bruyns* 5060 (no specimen). 3224 (Graaff-Reinet): (–BD), *Bruyns* 1960 (NBG). 3225 (Somerset East): (–AB), *Bruyns* 1767 (NBG); (–BA), *J.R. James* (BOL).

3.2 *Ceropogia dinteri* Schltr.

Dinter first collected this species around Rehoboth, where it has not been seen again. Several gatherings have been made from west of Outjo to Grootfontein (*Bruyns* 1984). The four collections listed below extend the known distribution over 400 km to the north and make it possible that this rare and inconspicuous species occurs in Angola.

Plants were found on dolomite and granite hillsides growing between rocks or in stony bare patches under trees. Tubers were observed from 25–60 mm in diameter. The stem (1.0–1.5 mm thick) is frail and spindly but reaches a height of over 500 mm with leaves up to 100 mm long. If the plant is growing in the open among short grasses, the stem is short—the stem in Figure 12 was about 150 mm long. Flowers are exceptionally variable with no two the same in size, shape or colouring. The differences between flowers illustrated in Dyer (1983: t. 17) and the present Figures 12 & 13C give some idea of this variability.

Specimens examined

NAMIBIA.—1713 (Swartbooisdrif): (–AC), 1 200–1 500 m, *Bruyns* 4092 (BOL); (–DA), 1 170 m, *Bruyns* 4095, 1813 (Opauwo); (–DD), *Bruyns* 5548 (BOL); south of Kaoko Otavi, 18-02-1993, *Bruyns* 5557 (K).

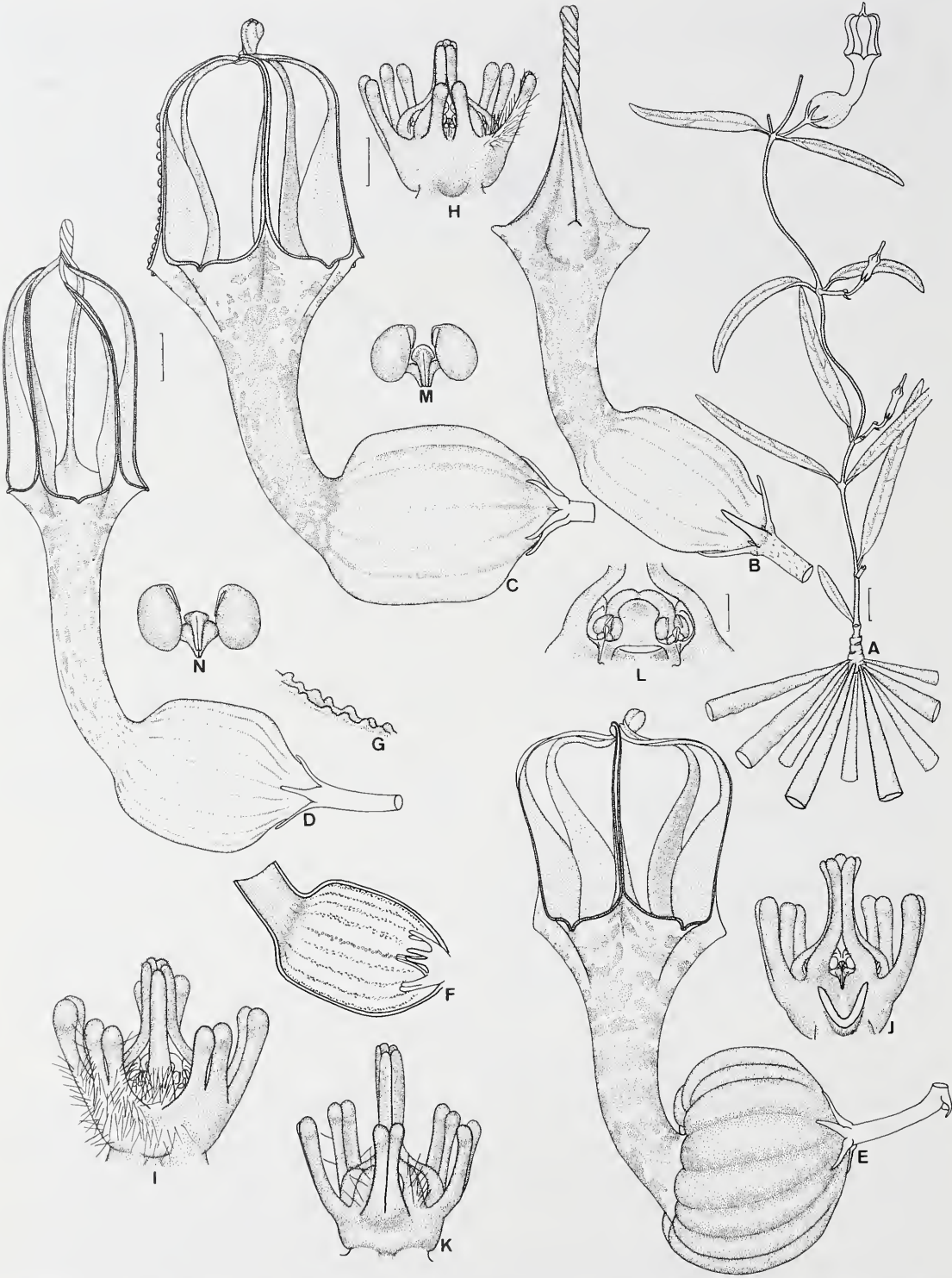


FIGURE 11.—*Ceropegia filiformis*. A, plant; B, bud; C–E, flower; F, l.s. of inflated base of flower: longitudinal ridges of papillae; G, papillae from within basal inflation of flower. H–L, gynostegium: J, one corona lobe removed; L, top, outer corona and one inner corona lobe removed, anthers and $\pm$ elongated style-head. M, N, pollinaria. Scale bars: A, 10 mm; B–F, 3 mm (at C); G–K, 1 mm (at H); L, 0.5 mm; M, N, 0.25 mm (at H). A, B, C, I, L, *Bruyns* 3275; D, K, N, *Bruyns* 3523; E, J, M, *Bruyns* 1960; F, G, H, *Meve* 347.



FIGURE 12.—*Ceropegia dinteri*, Bruyns 5557. Flower: corolla tube 41 mm long.

4. GOMPHOCARPUS R. Br.

According to Bullock (1952: 406) and Nicholas & Goyder (1992), the genus *Asclepias* should be confined to species from the New World since the type species, *A. syriaca* L., is an American species. Most of the larger, shrubby species from Africa placed in *Asclepias* by Brown should be referred to *Gomphocarpus* R. Br. The majority of the names have already been transferred to *Gomphocarpus* and it is only necessary now to decide which species occur in Namibia.

In Kolberg *et al.* (1992), *Asclepias buchenaviana* and *A. fruticosa* appear under *Asclepias* whereas *Gomphocarpus tomentosus* is listed under *Gomphocarpus*. If Bullock's system is to be used then clearly this is inconsistent and all three should appear under *Gomphocarpus* as in Bullock (1952). Three other species are also known from Namibia and are listed neither in Huber (1967) nor Kolberg *et al.* (1992).

A key is provided for all the species now known for Namibia and, since the synonymy of some is rather complicated, this is listed and discussed briefly.

Key to *Gomphocarpus* in Namibia

- 1a Leaves not more than 2 mm broad, follicles 4–6 mm broad when mature *G. filiformis*
- 1b Leaves broader than 4 mm, follicles usually much more than 15 mm broad when mature:

- 2a Plant glabrous in all parts, leaves at least 25 mm broad with rounded lobes clasping stem at base *G. glaucophyllus*
- 2b Plant pubescent or puberulous at least on young shoots and leaves, leaves less than 20 mm broad at max., subsessile to shortly petiolate without stem-clasping basal lobes:
- 3a Leaves oblong-lanceolate to elliptic, usually rounded at base, coriaceous and somewhat rigid *G. cancellatus*
- 3b Leaves linear or linear-lanceolate, acute, tapering gradually into petiole, thin:
- 4a Follicle without bristles on exterior, produced into apical beak at least 25 mm long *G. rostratus*
- 4b Follicle covered with soft bristles, beak not more than 15 mm long:
- 5a Young parts of stem, leaves and inflorescences densely white-tomentose (plant grey-green) *G. tomentosus*
- 5b Young parts of stem, leaves and inflorescence not densely white-tomentose (plant yellow-green) *G. fruticosus*

4.1 *Gomphocarpus cancellatus* (Burm. f.) Bruyns, comb. nov. *Asclepias cancellata* Burm. f., Flora Indica: cui accedit series zoophytorum indicorum nec non prodromus florae capensis: 7 (betw. 1 March and 6 Apr. 1768).

A. rotundifolia Miller (1768).

A. arborescens L.: 216 (1771). *Gomphocarpus arborescens* (L.) W.T. Aiton: 79 (1811).

A. pubescens L.: 215 (1771).

Brown (1907–1909) was incorrect in using the name *A. rotundifolia* Miller as this was published on 16 April 1768, slightly after *A. cancellata*. Several other names exist for this plant, of which only *Asclepias arborescens* L. has been transferred to *Gomphocarpus*.

G. cancellatus is common in the southwestern Cape and even occurs in places as a roadside weed. In Namaqualand and the Richtersveld it is rare and there appears to be only a single record of its occurrence in Namibia, some distance north of Rosh Pinah but well within the winter rainfall zone.

Specimen examined

NAMIBIA.—2716 (Witpütz): (–DA), Bruyns 3927 (BOL).

4.2 *Gomphocarpus filiformis* (E. Mey.) Dietr., Synopsis plantarum 2: 900 (1839–1852). *Lagarinthus filiformis* E. Mey.: 203 (1836–1838). *Asclepias filiformis* (E. Mey.) O. Kunze: 268 (1886) non Jacq. (1760).

Asclepias buchenaviana Schinz: 261 (1888). *A. filiformis* var. *buchenaviana* (Schinz) N.E. Br.: 336 (1902–1904).

The name *Asclepias buchenaviana* has become familiar. The species was first described as *Lagarinthus filiformis* by Meyer in 1837 but this name cannot be used in *Asclepias* because of *Asclepias filiformis* Jacq. (1760), a species from the Caribbean. However, there is no reason for it not to be used in *Gomphocarpus*.

4.3 *Gomphocarpus fruticosus* (L.) W.T. Aiton, Hortus kewensis (1810–1813).

Asclepias fruticosa L.: 216 (1753).

4.4 *Gomphocarpus glaucophyllus* Schltr. 19 (1894).*Asclepias glaucophylla* (Schltr.) Schltr.: 455 (1896).

Rare, only found in the northeastern portion of Namibia.

*Specimen examined*NAMIBIA.—1718 (Nkurenkuru): (–CD), *De Winter* 3881 (WIND).4.5 *Gomphocarpus rostratus* (N.E. Br.) Bullock in

Kew Bulletin: 410 (1952).

Asclepias rostrata N.E. Br.: 331 (1902–1904).

A widespread species in tropical Africa known from Kenya, Tanzania (Bullock l.c.), Angola and Botswana (Brown l.c.) and from two collections in Namibia.

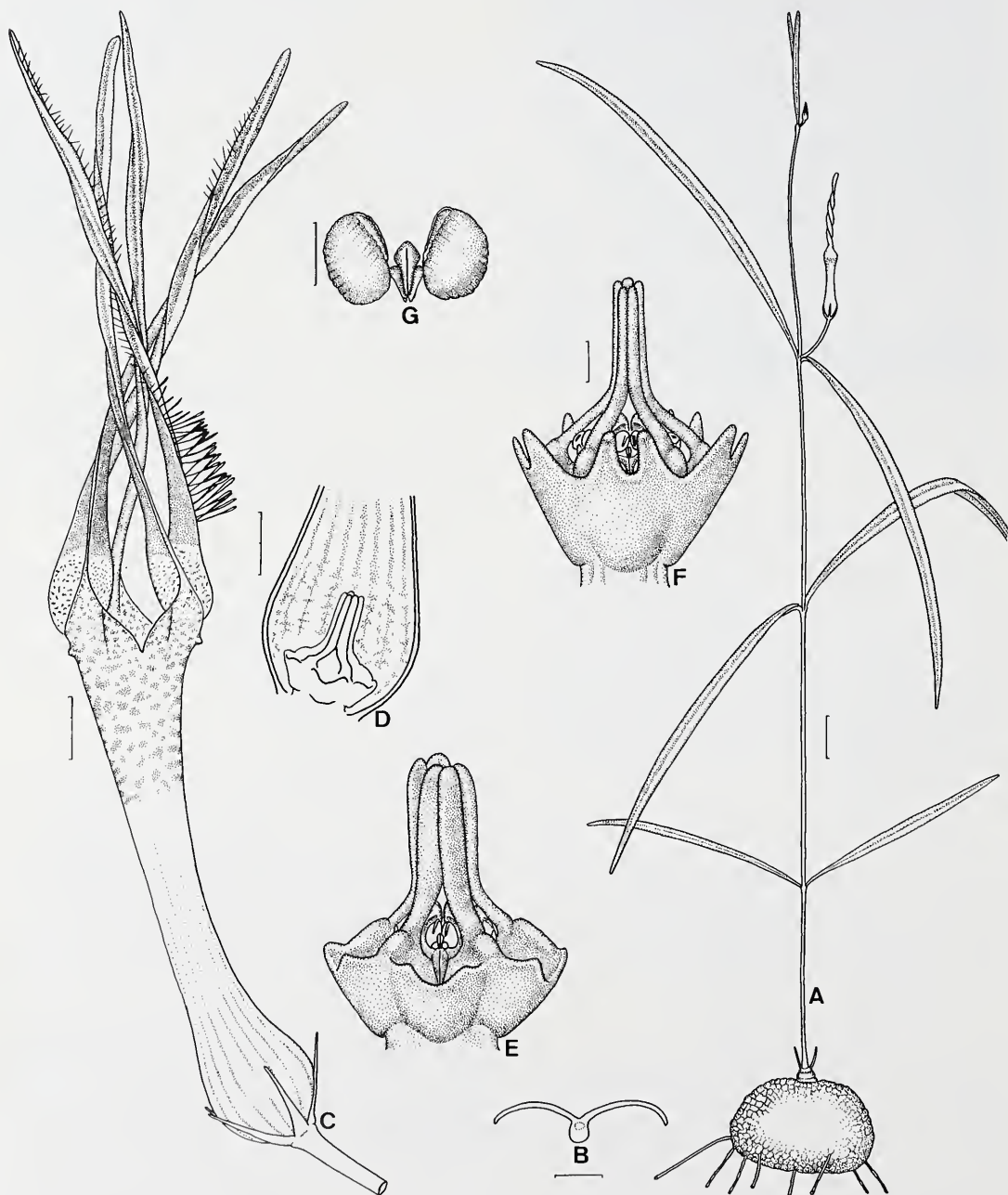


FIGURE 13.—*Ceropegia dinteri*. A, plant; B, cross-section of leaf taken more or less in middle; C, flower; D, base of corolla dissected; E, F, gynostegium; G, pollinarium. Scale bars: A, 10 mm; B, 1 mm; C, 3 mm; D, 2 mm; E, F, 0.5 mm; G, 0.25 mm. F drawn from Bruyns 2062, Outjo, remainder from Bruyns 4095.

Specimens examined

NAMIBIA.—1719 (Rundu): (–DC), *De Winter & Marais* 5037 (WIND). 1724 (Katima Mulilo): (–DD), *Killick & Leistner* 3153 (WIND).

4.6 *Gomphocarpus tomentosus* Burch., *Travels* 1: 453 (1822). *Asclepias burchellii* Schltr.: 336 (1895).

Bullock (1952: 406) regarded this taxon as a synonym of *G. fruticosus* but, as Huber (1967) pointed out, two distinct species appear to be involved.

5. PACHYCARPUS E. Mey.

Smith (1988) revised the southern African species of *Pachycarpus*, recognising 24 species for the region. All of them seem to occur only on the eastern side of southern Africa and neither there nor in Huber (1967) are any species mentioned for Namibia. Nevertheless, as early as 1955, B. de Winter gathered a plant clearly identifiable as a *Pachycarpus* in northern Namibia. Recent collections by B. Strohbach and myself have again brought to light the same taxon.

5.1 *Pachycarpus schweinfurthii* (N.E. Br.) Bullock

According to Bullock (1953), *P. schweinfurthii* is very widely distributed in tropical Africa from Nigeria and Sudan southwards to Angola and Zimbabwe. In Namibia it

only occurs in the moister northeastern region (Figure 5) and its occurrence in Botswana is also likely.

I have attempted to insert *P. schweinfurthii* into Smith's (1988) key to the southern African species of *Pachycarpus* (see below) by adding an extra couplet, and a description is also provided. Unfortunately the drawings in Smith's paper are not clear and it is hard to see what the characters used in the key really refer to, especially as there is no explanation of the terminology adopted for the different floral parts. In the specimen here the guide rails (anther wings of Smith) are a little over 3 mm long. The distance from the edge of the rail to the centre of the flower increases as one goes from the corpusculum towards the base of the flower (clearly seen in Figure 14D) and I assume that this is what Smith means by 'outer margin concave'. I have changed this to 'with concave margin' as there is no 'inner' margin which the use of 'outer' implies.

It may be of use to observe here that the 'corona lobes' referred to above and throughout Smith (1988) are the 'staminal corona' lobes of Kunze (1982) corresponding to the 'inner corona lobes' of the Stapelieae. It seems to be assumed generally that in the species in the *Asclepias*–*Gomphocarpus*–*Pachycarpus*–*Schizoglossum* complex the corona only consists of these five lobes of staminal origin. However, in most species I have looked at, there are five more lobes which are of interstaminal origin (Kunze 1982). Unlike in the Stapelieae (where these 'outer corona lobes' are generally well developed), here they are minute and mostly hidden behind and below the large mouth at

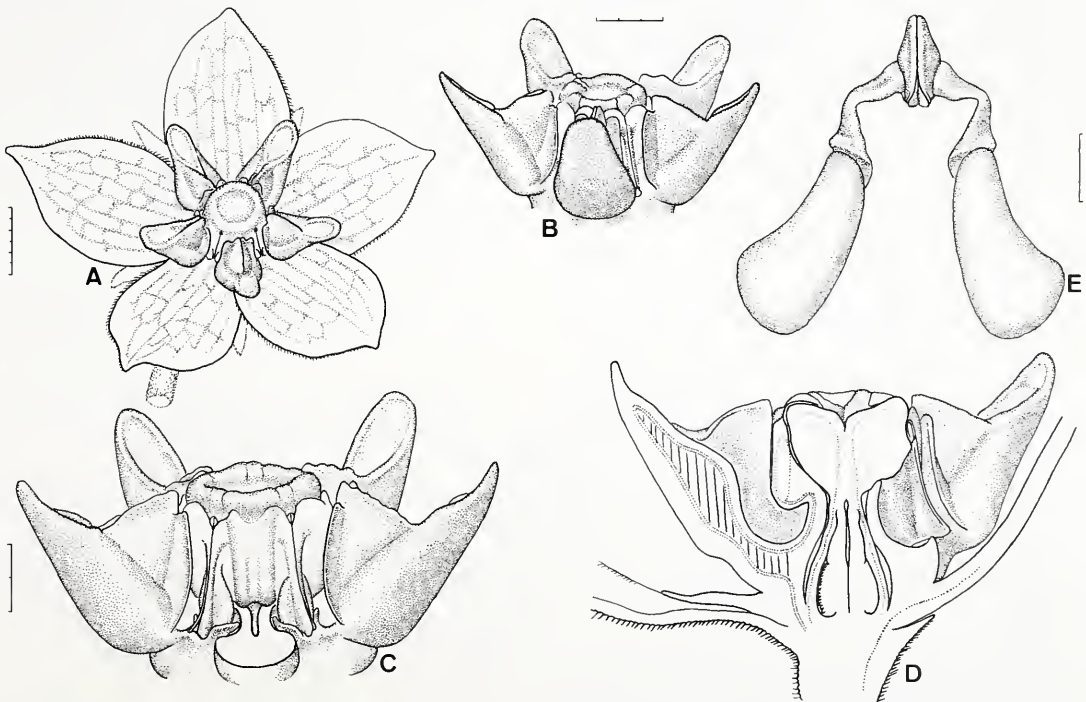


FIGURE 14.—*Pachycarpus schweinfurthii*, *Bruyns* 5484. A, flower; B, gynostegium; C, gynostegium with one corona lobe removed; D, half flower; E, pollinarium. Scale bars: A, 6 mm; B, 3 mm; C, D, 2 mm (at C); E, 0.5 mm.



FIGURE 15.—*Pachycarpus schweinfurthii*, Bruyns 5484, in habitat.

the base of the guide rail so they have probably been missed. They are clearly visible in Figure 14C, each lobe divided into two narrow, widely diverging teeth encircling the base of the guide rail.

Part of key taken from Smith (1988)

- 19a Guide rail (anther wings) 1.3–2.4 mm long with $\pm$ straight margin *P. natalensis*
 19b Guide rail 3.0–7.2 mm long with concave margin:
 20a Flower rotate-campanulate, corolla lobes spreading but curved inwards in upper half *P. schweinfurthii*
 20b Corolla lobes reflexed:
 20ba Keel of corona lobe taller than broad *P. reflectens*
 20bb Keel of corona lobe not taller than broad . . . *P. appendiculatus*

Plant to 450 mm tall, consisting of 1–several ascending stems, all parts stiffly pubescent except where indicated otherwise (Figure 15). *Stems* 3–5 mm thick. *Leaf* 30–70 $\times$ 20–50 mm, ovate to ovate-lanceolate, apex rounded, base truncate to cordate, green with many prominent parallel veins, petiole 4–10 mm long. *Peduncle* 20–55 mm long, $\pm$ 2 mm thick, bearing 4–10 $\pm$ simultaneously opening flowers, bracts narrowly lanceolate, 6–14 mm long, pedicels 15–18 mm $\times$ 1.0–1.5 mm thick. *Sepals* 10–12 $\times$ 2–3 mm (at base), widening very slightly above base then lanceolate, pubescent below, glabrous above. *Corolla* 30–35 mm diam., rotate-campanulate; *lobes* 15 $\times$ 9 mm, ovate, finely pubescent outside and on one margin, glabrous within, white suffused with reddish outside, inside white with conspicuous greyish red veining. *Gynostegium* 14–15 mm across; *outer corona lobes* minute, bifid and spreading adpressed to base of guide rails; *inner corona lobes* ascending, $\pm$ 7 mm long, exceeding height of style-head, with keel 2 mm tall, just equalling style-head, keel and part below it white, part above keel pinkish red.

Specimens examined

NAMIBIA.—1917 (Tsumeb), Otavi Mountains, (–DB), Bruyns 5484 (BOL, K). 1920 (Tsumkwe): (–BC), Strohbach 1268 (WIND).

6. SCHIZOGLOSSUM E. Mey. *sensu lato* in Namibia

During recent expeditions to the northern parts of Namibia several plants belonging to the former genus *Schi-*

zoglossum have been collected. These have proved very difficult to identify to species level and information on these collections is presented here in the hope that they may add to the knowledge of the group. This group was worked on extensively by Kupicha (1984) who, following Bullock (1952), resurrected the genus *Aspidoglossum* E. Mey. and created a new genus *Miraglossum* Kupicha as well as concurring with Bullock's resurrection of *Stenostelma* Schltr. and *Glossostelma* Schltr. However, she provided no keys to all these genera and various lengthy diagnoses have to be perused to sift out the salient details for identifications.

In Kolberg *et al.* (1992) various species were left erroneously in *Schizoglossum* with Kupicha cited as the authority for this. In fact she placed *S. baumii* Schltr. ex N.E. Br. under *Aspidoglossum masaicum* (N.E. Br.) Kupicha (not *S. bidens* subsp. *atrorubens* (Schltr.) Kupicha) and *S. pentheri* Schltr. tentatively under *Aspidoglossum erubescens* (Schltr.) Bullock so that *Schizoglossum sensu stricto* is not known in Namibia. Nevertheless, I have included it in the key which follows. The differentia that Kupicha (1984) gives for *Stenostelma* seem to me to have so much overlap with the other genera that I have reverted to the shape of the style-head to separate this genus from the others as Schlechter (1894) originally did: this works for *S. capense* but may cause problems with the other species tentatively assigned to this genus by Kupicha.

Key to genera of the *Schizoglossum* complex in Namibia

- 1a Style-head conical, anther appendages much exceeding style-head connivent in centre and hiding it entirely, caudicles conspicuously angled, broadly attached to corpusculum *Stenostelma*
 1b Style-head flat with slight depression in centre, anther appendages adherent to sides of apex and not covering it, caudicles not conspicuously angled with narrow attachment to corpusculum:
 2a Inflorescences pedunculate, pollinia medially attached to caudicle with germinating mouth on outer side *Schizoglossum*
 2b Inflorescences sessile, pollinia subapically attached usually without germinating mouth, if this is present then located at point of attachment of pollinium to caudicle:
 3a Corona lobes fleshy, pollinia without germinating mouth *Miraglossum*
 3b Corona lobes thin, pollinia often with germinating mouth *Aspidoglossum*

6.1 *Aspidoglossum carinatum* (Schltr.) Kupicha

The taxon illustrated in Figure 16 keys out in Huber (1967) as *Schizoglossum pentheri*. In Kupicha (1984) one arrives at *Aspidoglossum carinatum* (Schltr.) Kupicha rather than *A. erubescens* which is where she tentatively placed *S. pentheri* in synonymy. The pollinium lacks the conspicuous germinating zone supposedly typical of *A. erubescens* and so we are unlikely to be dealing with that species.

According to Kupicha (1984: 640), *A. carinatum* occurs in the eastern Cape Province and Natal. The present, rather exceptional extension of its distribution into north-

ern Namibia stretches credibility somewhat. In addition, the corona does not correspond very exactly with that of *A. carinatum*: the ventral appendage of the corona is slender and much exceeds the apical process (not broadly triangular). However, there appears to be nowhere else to place this collection and since the taxonomy of this whole group remains such a mess, I would prefer to avoid describing new taxa which might further confound the situation.

It should be observed that the stem here is uniformly finely pubescent all round and the leaves are pubescent on the ventral surface and glabrous on the dorsal except for the pubescent midrib (Figure 16F). Unless damaged, the plant always consists of a simple, slender, erect stem up to 300 mm tall with narrow leaves and many small clusters of nearly sessile flowers. There is a small, neat, carrot-like tuber just beneath the surface of the soil (one excavated was ± 60 mm long and 10 mm broad at apex).

Specimen examined

NAMIBIA.—1917 (Tsumeb): Otavi Mountains, (—DB), *Bruyns 5488* (BOL).

6.2 *Schizoglossum saccatum* Bruyns, sp. nov., a ceteris speciebus pilis longis densis in lobis corollae et lobis corollae crassioribus processa apicale horizontale breve discedit. Typus: Namibia, 1813 (Opuwo), south of

Kaoko Otavi, (—DD), 1 400 m, *Bruyns 5558* (BOL, holo.; K, WIND, iso.).

Plant much branched at ground level from an underground rootstock, with milky latex. *Stems* 70–200 $\times$ 1.5–2.0 mm, ascending, hairy all round, internodes 7–25 mm long. *Leaves* 20–70 $\times$ 2.5–4.0 mm, narrowly linear, sessile, ventral surface pilose, dorsal glabrous except on midrib, margins recurved, acute at apex and at base. *Flowers* in fascicles mostly of 4 arising alongside all except the basal nodes; *peduncle* 7–20 $\times$ $\pm$ 1 mm, pilose along one side only, with several filiform bracts up to 3 mm long at apex; *pedicel* 7–9 mm long, about 0.5 mm thick, pilose. *Sepals* dorsally pilose, ventral surface glabrous, 4–5 $\times$ 1 mm (at base), lanceolate, usually recurved towards apex, green. *Corolla* divided right to base; *lobes* 6.0 $\times$ 2.5 mm (at base), ovate-lanceolate, ascending-spreading with recurved margins and apex, dorsal surface glabrous, ventral surface convex and densely white-pilose especially towards apex with hairs up to 1.5 mm long, green with faint longitudinal purplish stripes. *Gynostegium* 2.0 $\times$ 5.5 mm, glabrous, white except for purplish pink dorsal apex; *outer corona lobes* minute, truncate-emarginate, beneath guide rails; *inner lobes* massive, inflated, $\pm$ ovoid when viewed from above with small apical process projecting horizontally onto anther appendage and broad rounded dorsal process. Fruit and seed not seen. Figure 17.

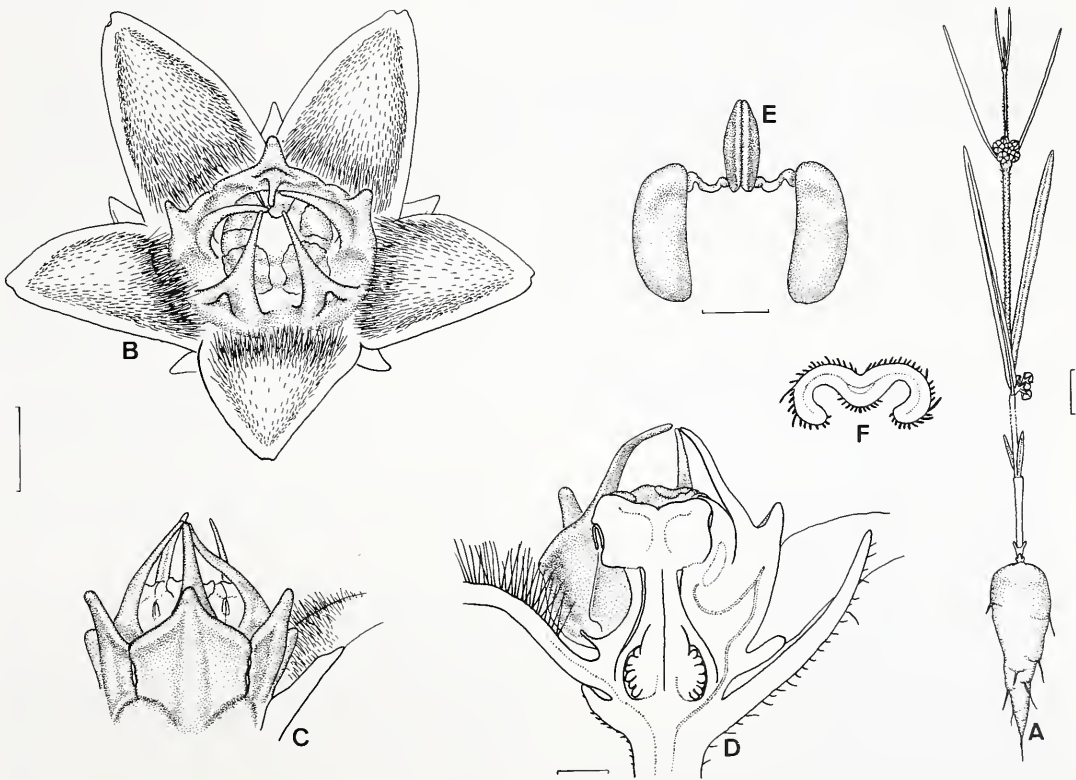


FIGURE 16.—*Aspidoglossum carinatum*, Bruyns 5488. A, plant, much reduced in length (up to 450 mm tall); B, flower; C, gynostegium; D, half flower; E, pollinarium; F, cross-section of leaf taken near middle showing distribution of thickened hairs. Scale bars: A, 10 mm; B, C, F, 1 mm (at B); D, 0.5 mm; E, 0.25 mm.

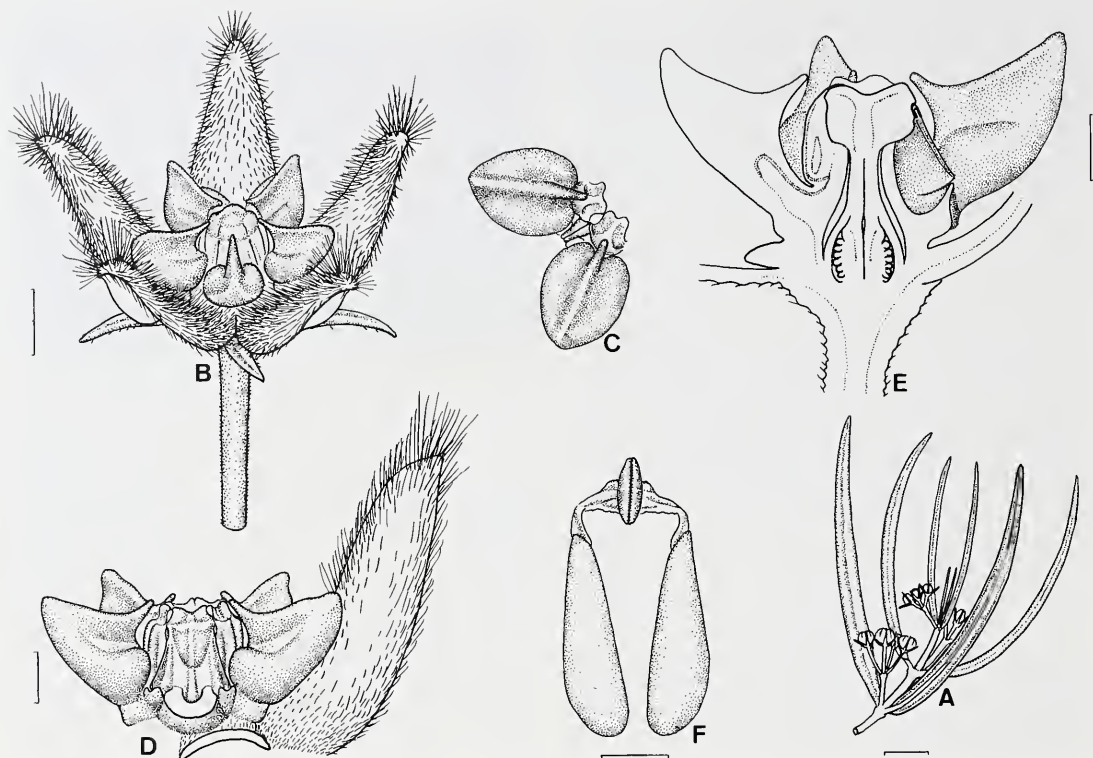


FIGURE 17.—*Schizoglossum saccatum*, Bruyns 5558. A, portion of plant; B, flower; C, face view of part of corona; D, gynostegium with one corona lobe removed; E, half flower; F, pollinarium. Scale bars: A, 10 mm; B, 2 mm; C, D, 1 mm (at D); E, 1 mm; F, 0.25 mm.

This species is only provisionally placed under *Schizoglossum* with which it shares the pedunculate inflorescence but, if Kupicha's (1984) sense of the genus is applied, little else. In *Miraglossum*, where the fleshy corona lobes and lack of germinating mouth on the pollinia suggest it might belong, it would be a very odd bedfellow with the other species of this small, compactly distributed genus: as Kupicha (in litt.) points out, most of them have whorled leaves in the flowering part of the stem, sessile inflorescences and pollinia attached to the caudicle somewhat on their inner side rather than apically as in this new species. It also seems that the fleshiness of the corona lobes exceeds anything known in *Miraglossum*. D. Goyder at Kew has tried to match it with existing material or existing genera without success.

Plants were common among limestone chunks in a flat *Sesamothamnus*-dominated area, growing with a small spiny *Euphorbia* and many other succulents. They are generally small and inconspicuous and, once the grass begins to grow, are probably difficult to find.

6.3 *Stenostelma capense* Schltr.

This species seems to be widespread but relatively uncommon in northern Namibia. Schlechter (1894) based *Stenostelma* on the conical shape of the style-head. From the half flowers shown here (compare Figure 18H with Figure 1D) it can be seen that the style-head is indeed differently shaped to that typical amongst the genera *As-*

clepias, *Gomphocarpus*, *Pachycarpus* and *Schizoglossum*. The anther appendages are also much more conspicuous. Instead of being adpressed to the edge of the pentagonal style-head they here only touch the edge, rise up and are connivent in the centre, in so doing hiding the entire style-head from view.

In the material illustrated here the stems are pilose in a longitudinal band on one side (the side changing after each node) and are not pilose all round as given by Huber (1967). On the other hand the corolla lobes are papillate all over the inner surface and not glabrous as Schlechter described them. The very tiny outer corona lobes consist of a single, erect tooth beneath the guide rail (Figure 18G).

Specimens examined

NAMIBIA.—1918 (Grootfontein): Gobis Water, (–AC), Bruyns 5499 (BOL). 1920 (Tsumkwe): 15 km southeast of Tsumkwe, (–DA), Bruyns 5834 (BOL).

7. *Stigmatorhynchus hereroensis* Schltr.

The genera of the Marsdenieae are so poorly known that every attempt should be made to obtain and publish information on them so that an eventual re-assessment of the tribe is possible.

S. hereroensis is common and fairly widespread in the northern portion of Namibia usually growing in areas with much surface limestone. The distribution (Figure 19,

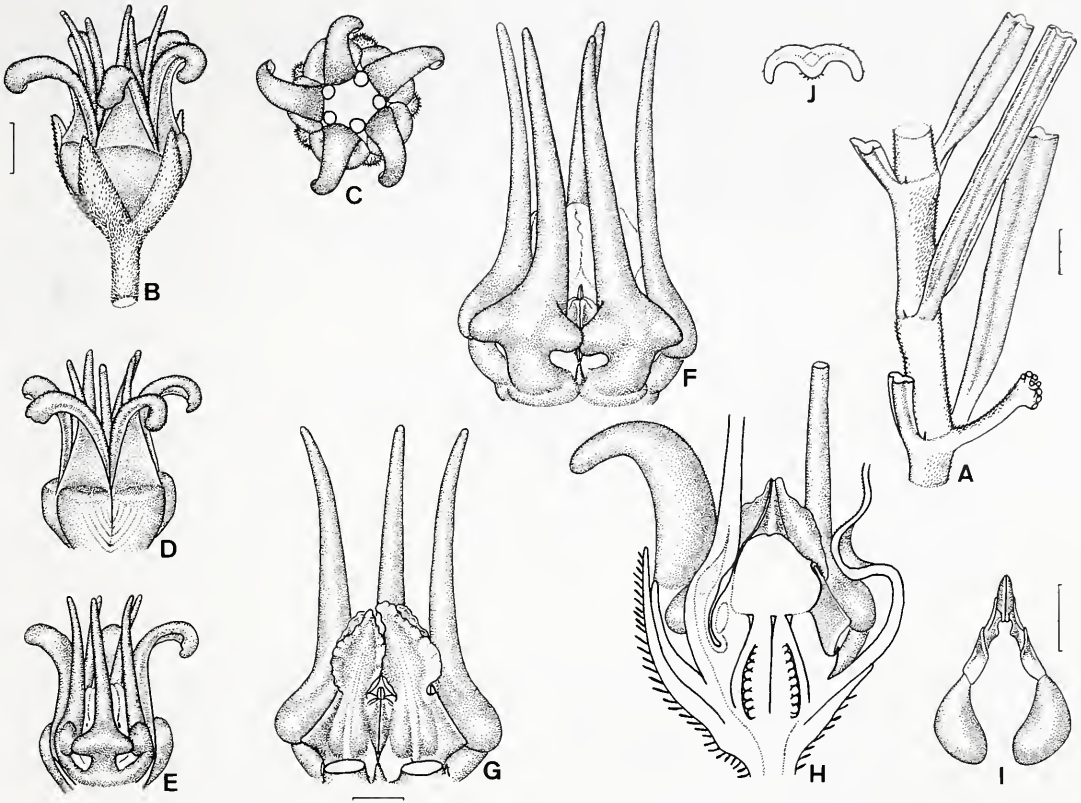


FIGURE 18.—*Stenostelma capense*, Bruyns 5834. A, part of plant: stem virtually glabrous in patch below insertion of each petiole, peduncle only hairy on upper side. Flowers produced in dense, simultaneously opening clusters on several such peduncles towards apex of stem; B, C, flower; D, flower with sepals removed; E, flower with two corolla lobes excised; F, gynostegium; G, gynostegium with two corona lobes removed; H, half flower (small oval area demarked inside cut corona lobe is hollow); I, pollinarium; J, cross-section of leaf, taken near middle. Scale bars: A, 2 mm; B–E, J, 1 mm (at B); F–H, 0.5 mm (at G); I, 0.25 mm.

drawn up from material in WIND and BOL) seems to be bounded to the north and east by regions covered with deep Kalahari sand but it remains possible that it extends into Angola and Botswana. Plants often grow in the open but may also be found growing inside other bushes. They are usually heavily grazed.

S. hereroensis is a shrub-forming species. Plants usually form a rigid, round bushlet up to about 300 mm tall but, if sheltered, may reach 1 m in height, although they never show any tendency to climb. The grey, woody stems contain a milky latex.

Plants bear small white flowers in nearly sessile, simultaneously opening clusters along the stems. Within each flower is a dense beard of whitish hairs, beginning on the lobes, extending into the tube and blocking the throat of the tube. Peculiar to this species (to the genus?) is the very long, cylindrical style-head which protrudes slightly from the tube, and the pair of ovules in each carpel. One of these ovules seems to abort as each pod contains only a single, quite large seed. The pods may be paired or solitary and when paired are divergent from one another at about 120°. The pollinia are very small and attached by long, slender caudicles to the small corpusculum (Figure 20).

Schlechter (1914) placed three species in *Stigmatorhynchus*, of which the other two, *S. umbelliferus* (K. Schum.) Schltr. and *S. stelostigma* (K. Schum.) Schltr. (from Tanzania and Somalia respectively) are unknown

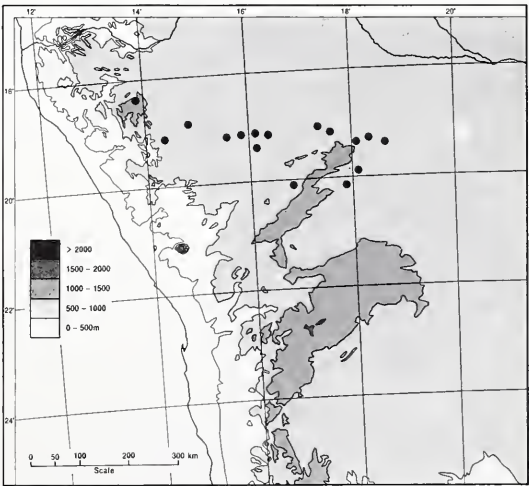


FIGURE 19.—Distribution of *Stigmatorhynchus hereroensis* in Namibia (from records in WIND, BOL).

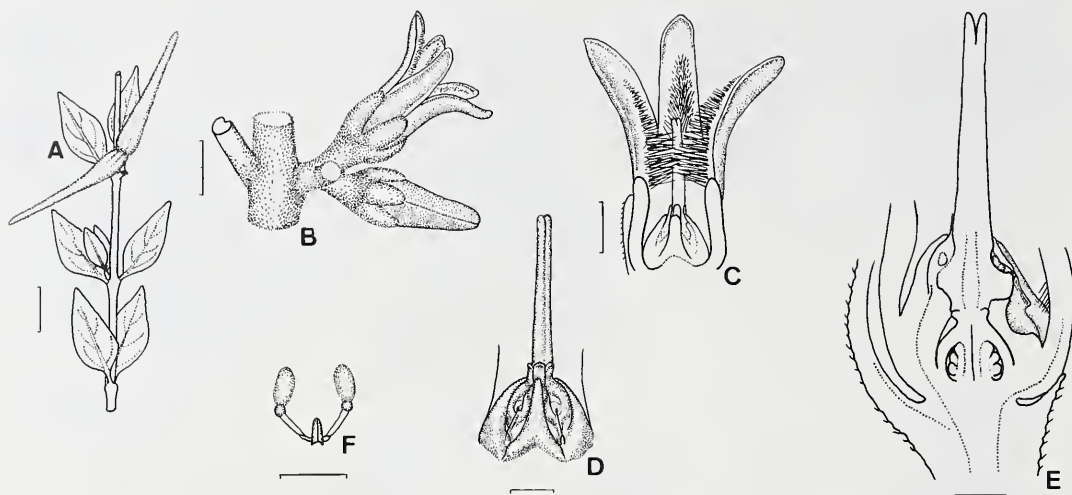


FIGURE 20.—*Stigmatorhynchus hereroensis*, Bruyns 5833. A, portion of plant with paired foliaceous bracts; B, flower; C, dissected flower; D, gynostegium; E, half flower, each carpel has two ovules; F, pollinarium with caudicles stretched out. Scale bars: A, 10 mm; B, 2 mm; C, 1 mm; D, 0.5 mm; E, 0.5 mm; F, 0.25 mm.

to me. Bullock (1954) transferred *S. stelostigma* back to *Marsdenia* R. Br. so that, at present, *Stigmatorhynchus* contains only two species. It should be noted that Schlechter's illustration (1914) is not very accurate: the pollinaria are very different to what he has shown and the style head maintains a roughly equal diameter right to the apex, where it may sometimes be bifid.

ACKNOWLEDGEMENTS

I wish to thank A. Nicholas and D.J. Goyder for useful information on members of the Asclepiadeae, where my knowledge is patchy. The Curators of WIND and PRE are thanked for the loan of material.

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An annotated list of Urediniomycetes (rust fungi) from South Africa 1: Melampsoraceae and Pucciniaceae, excluding *Puccinia* and *Uromyces*

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Keywords: checklist, new records, taxonomy, Urediniomycetes

ABSTRACT

Up-to-date information is given on the identity, occurrence, nomenclature, host ranges, geographical distribution and literature references of the Urediniomycetes in South Africa. Species of the family Melampsoraceae and all species of the family Pucciniaceae other than those in the genera *Puccinia* Pers. and *Uromyces* (Link) Unger are listed. New species records since 1945 include the following: *Melampsora allii-populina* Kleb., *Melampsora coleosporioides* Dietel, *Melampsora larici-populina* Kleb., *Melampsora medusae* Thüm., *Frommea obtusa-duchesneae* (Arthur) Arthur, *Hemileia gardeniae-thunbergiae* Maubl. & Roger, *Phakopsora gossypii* (Arthur) Hirats. f., *Uromycladium tepperianum* (Sacc.) McAlpine and *Tranzschelia discolor* (Fuckel) Tranzschel & M.A. Litv. Although many species of rusts have already been recorded, these are thought to represent only a small percentage of the rust population in southern Africa. Furthermore, only a small portion of rust specimens at present housed at PREM have so far been studied. Continued research on this economically important group of fungi is therefore essential.

UITTREKSEL

Die jongste inligting oor die identiteit, voorkoms, nomenklatuur, gasheerreeks, geografiese verspreiding en literatuurverwysings van die Urediniomycetes in Suid-Afrika word gegee. Spesies van die familie Melampsoraceae asook alle spesies van die familie Pucciniaceae behalwe dié van die genusse *Puccinia* Pers. en *Uromyces* (Link) Unger word gelys. Nuwe spesierekords sedert 1945 sluit die volgende in: *Melampsora allii-populina* Kleb., *Melampsora coleosporioides* Dietel, *Melampsora larici-populina* Kleb., *Melampsora medusae* Thüm., *Frommea obtusa-duchesneae* (Arthur) Arthur, *Hemileia gardeniae-thunbergiae* Maubl. & Roger, *Phakopsora gossypii* (Arthur) Hirats. f., *Uromycladium tepperianum* (Sacc.) McAlpine en *Tranzschelia discolor* (Fuckel) Tranzschel & M.A. Litv. Alhoewel talle spesies reeds aangeteken is, verteenwoordig hulle vermoedelik slegs 'n klein persentasie van die roespopulasie van suidelike Afrika; boonop is slegs 'n klein gedeelte van die roes-eksemplare wat in PREM gehuisves word, reeds bestudeer. Daarom bly navorsing op hierdie ekonomies belangrike groep swamme steeds noodsaaklik.

INTRODUCTION

The rust fungi (Urediniomycetes), being obligate plant parasites, constitute one of the most economically important groups of fungi. The rusts in South Africa have been neglected for some time and our knowledge of the occurrence of rust fungi in this country is based largely on the publication by Doidge (1950). A few subsequent lists of plant diseases in South Africa (Doidge *et al.* 1953; Gorter 1977, 1979, 1981, 1982) have provided additional information on certain species.

As the records in the National Collection of Fungi represent mainly early collections up to 1945, catalogued by Doidge (1950), a significant number of new records of genera and species are to be expected. Furthermore, many of the recorded rusts and their hosts have undergone a change of name, and several new host records have been reported. The need for an up-to-date list is therefore evident.

This publication is the first in a series of lists on the rust fungi recorded for South Africa. It deals with the family Melampsoraceae and all genera of the family Puc-

ciniaceae other than *Puccinia* Pers. and *Uromyces* (Link) Unger. These will be dealt with in separate papers, as will the form-genera *Aecidium* Pers. and *Uredo* Pers. The aim of the present publication is to combine all previous information in one list. Doidge (1950) included 17 species under the family Melampsoraceae, 264 species under the Pucciniaceae and 143 species under the Imperfect rusts. In this paper nine new species records are added, seven species previously recorded from South Africa are excluded as they were based on specimens from outside the region covered by the present list, five species are placed in synonymy and one previously incorrectly identified species is correctly named.

The list covers two families: Melampsoraceae and Pucciniaceae. Species are listed alphabetically. Each name (in bold type) is given with the relevant literature references, synonyms (in italics, preceded by =), correct host names (in italics) and reference to specimens in the National Collection of Fungi (PREM) together with their localities. Information on the geographical distribution of all species in South Africa is summarised in Table 1. The geographical area referred to as South Africa in this publication includes the Republic of South Africa with the former Republics of Bophuthatswana, Ciskei, Transkei and Venda. An alphabetical list with hosts is included in Table 2. An alphabetical list of hosts (Table 3) is also added; the scientific names are the names listed by the National

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TABLE 1.—Summary of rust distribution in South Africa (1993)

Name	General remarks	Province			
		Cape	Natal	OFS	Tvl
<i>Cerotelium fici</i>	fairly common	x	x		x
<i>Coleosporium</i>					
<i>clematidis</i>	fairly common	x	x		x
<i>hediotidis</i>	common, widespread	x	x	x	x
<i>ipomoeae</i>	few records		x		
<i>Cronartium</i>					
<i>gilgianum</i>	common	x	x		x
<i>zizyphi</i>	few records in Lowveld				x
<i>Diorchidium</i>					
<i>tricholaenae</i>	fairly common		x		x
<i>woodii</i>	fairly common in Natal		x		
<i>Endophyllum macowanii</i>	fairly common	x	x		x
<i>Frommea obtusa-duchesneae</i>	few records		x		x
<i>Hamasporea longissima</i>	common, widespread	x	x	x	
<i>Hemileia</i>					
<i>canthii</i>	few records, occasional		x		x
<i>evansii</i>	not common		x		
<i>fadogiae</i>	fairly common in Tvl		x		x
<i>gardeniae-thunbergiae</i>	not common				x
<i>scholzii</i>	not common		x		
<i>vastatrix</i>	common		x		x
<i>woodii</i>	common	x			x
<i>Kuehneola uredinis</i>	common on wild <i>Rubus</i> spp.	x		x	x
<i>Masseeëlla fluggeae</i>	few records				x
<i>Melampsora</i>					
<i>allii-populina</i>	not common				x
<i>coleosporioides</i>	not common		x		
<i>helioscopiae</i>	fairly widespread		x	x	x
<i>hypericorum</i> var. <i>australis</i>	fairly common		x		x
<i>larici-populina</i>	common		x	x	x
<i>lini</i>	not common		x		
<i>medusae</i>	common		x		x
<i>populnea</i>	fairly common		x	x	x
<i>ricini</i>	common, widespread		x	x	x
<i>vitellinae</i>	occasional		x	x	x
<i>Milesina</i>					
<i>dieteliana</i>	not common		x		
<i>nervisequa</i>	few records		x	x	x
<i>Phakopsora gossypii</i>	not common		x		
<i>Phragmidium mucronatum</i>	widespread on <i>Rosa</i> spp.	x	x	x	x
<i>Pucciniastrum agrimoniae</i>	fairly common		x	x	x
<i>Puccinosira dissotidis</i>	occasional in Natal		x		
<i>Ravenelia</i>					
<i>atrides</i>	occasional		x		x
<i>baumiana</i>	few records				x
<i>dichrostachydis</i>	not common		x		
<i>eliphantorrhizae</i>	central districts				x
<i>escharoides</i>	fairly common				x
<i>evansii</i>	fairly common		x		x
<i>glabra</i>	fairly common, E Cape	x			
<i>halsei</i>	few records		x		
<i>inornata</i>	E Cape	x			
<i>macowaniana</i>	very common, widespread	x	x	x	x
<i>minima</i>	fairly common (coastal)		x		
<i>modesta</i>	few records, occasional				x
<i>natalensis</i>	few records		x		
<i>peglerae</i>	occasional		x	x	
<i>pienaarrii</i>	common in Tvl		x		
<i>pretoriensis</i>	not common				x
<i>stictica</i>	common in Pretoria dist.				x
<i>tephrosiae</i>	not common, coastal		x		
<i>transvaalensis</i>	not common				x
<i>Schroeteriaster</i>					
<i>doidgeae</i>	not common				x
<i>stratosus</i>	few records, coastal		x		x
<i>Skierka robusta</i>	fairly common in Natal		x		
<i>Sphaerophragmium</i>					
<i>artabotrydis</i>	not common		x		
<i>dalbergiae</i>	fairly common		x		x
<i>Tranzschelia discolor</i>	very common (late summer)	x	x	x	x
<i>Uredinopsis pteridis</i>	few records, not common		x		
<i>Uromycladium tepperianum</i>	few records		x		
<i>Uropyxis gerstneri</i>	not common		x		

TABLE 2.—Alphabetical list of rusts with hosts

Name	Hosts
<i>Cerotelium fici</i>	<i>Ficus carica</i> , <i>F. cordata</i> subsp. <i>salicifolia</i>
<i>Coleosporium</i>	
<i>clematidis</i>	<i>Clematis brachiata</i> , <i>C. oweniae</i>
<i>hediotidis</i>	<i>Kohautia amatymbica</i> , <i>Oldenlandia</i> sp.
<i>ipomoeae</i>	<i>Hewittea sublobata</i>
<i>Cronartium</i>	
<i>gilgianum</i>	<i>E. lanceolata</i> , <i>E. natalensis</i> subsp. <i>natalensis</i> , <i>E. schimperii</i> subsp. <i>schimperii</i>
<i>zizyphi</i>	<i>Ziziphus mucronata</i> subsp. <i>mucronata</i> , <i>Ziziphus</i> spp.
<i>Diorchidium</i>	
<i>tricholaenae</i>	<i>Melinis repens</i> subsp. <i>repens</i>
<i>woodii</i>	<i>Milletia grandis</i>
<i>Endophyllum macowanii</i>	<i>Rhamnus prinoides</i>
<i>Frommea obtusa-duchesneae</i>	<i>Duchesnea indica</i>
<i>Hamasporea longissima</i>	<i>Rubus ludwigii</i> subsp. <i>ludwigii</i> , <i>R. pinatus</i> , <i>R. rigidus</i> , <i>R. transvaaliensis</i> , <i>Rubus</i> spp.
<i>Hemileia</i>	
<i>ancylanthi</i>	<i>Ancylanthos fulgides</i>
<i>canthii</i>	<i>Canthium ciliatum</i> , <i>C. mundianum</i> , <i>C. orbiculare</i> , <i>Canthium</i> spp., <i>Psydrax livida</i>
<i>evansii</i>	<i>Tricalysia capensis</i> var. <i>capensis</i> , <i>T. sonderiana</i>
<i>fadogiae</i>	<i>Fadogia cienkowski</i> , <i>F. tetraquetra</i> var. <i>tetraquetra</i> , <i>Fadogia</i> sp., <i>Pygmaeothamnus pygmaeum</i> , <i>P. zeyheri</i> var. <i>zeyheri</i>
<i>gardeniae-thunbergiae</i>	<i>Gardenia volkensii</i> subsp. <i>volkensii</i> var. <i>volkensii</i> , <i>G. thunbergia</i>
<i>scholzii</i>	<i>Clerodendrum glabrum</i> var. <i>glabrum</i> , <i>Clerodendrum</i> sp.
<i>vastatrix</i>	<i>Coffea arabica</i>
<i>woodii</i>	<i>Pachystigma latifolium</i> , <i>P. pygmaeum</i> , <i>Vangueria infausta</i> subsp. <i>infausta</i> , <i>Vangueria</i> sp., <i>Vangueria lanciflora</i>
<i>Kuehneola uredinis</i>	<i>Rubus apetalus</i> , <i>R. rigidus</i> , <i>R. transvaaliensis</i> , <i>R. ursinus</i> , <i>Rubus</i> spp.
<i>Masseeëlla fluggeae</i>	<i>Securinega virosa</i>
<i>Melampsora</i>	
<i>allii-populina</i>	<i>Populus deltoides</i>
<i>coleosporioides</i>	<i>Salix babylonica</i>
<i>helioscopiae</i>	<i>Euphorbia helioscopia</i> , <i>E. heterophylla</i> , <i>E. kraussiana</i> var. <i>kraussiana</i> , <i>E. striata</i> var. <i>striata</i> , <i>Euphorbia</i> spp.
<i>hypericorum</i> var. <i>australis</i>	<i>Hypericum aethiopicum</i> subsp. <i>aethiopicum</i> , <i>H. aethiopicum</i> subsp. <i>sonderi</i> , <i>H. lalandii</i>
<i>junodii</i>	<i>Vernonia colorata</i> subsp. <i>colorata</i>
<i>larici-populina</i>	<i>Populus deltoides</i> , <i>P. nigra</i> var. <i>italica</i> , <i>P. wislizenii</i> , <i>Populus</i> spp.
<i>lini</i>	<i>Linum africanum</i> , <i>L. usitatissimum</i>
<i>medusae</i>	<i>Populus deltoides</i> , <i>Populus</i> spp.
<i>populnea</i>	<i>Populus alba</i> , <i>Populus</i> spp.
<i>puccinioides</i>	<i>Helichrysum</i> sp.
<i>ricini</i>	<i>Ricinus communis</i>
<i>vitellinae</i>	<i>Salix mucronata</i> subsp. <i>capensis</i> , <i>Salix</i> spp.
<i>Milesina</i>	
<i>dieteliana</i>	<i>Polypodium lycopodioides</i>
<i>nervisequa</i>	<i>Cheilanthes viridis</i> var. <i>viridis</i> , <i>Rumohra adiantiforme</i>
<i>Phakopsora gossypii</i>	<i>Gossypium</i> sp.
<i>Phragmidium mucronatum</i>	<i>Rosa</i> spp.
<i>Pucciniastrum agrimoniae</i>	<i>Agrimonia bracteata</i> , <i>A. procera</i>
<i>Puccinosira dissotidis</i>	<i>Dissotis incana</i> , <i>D. longicaudata</i> , <i>D. princeps</i> var. <i>princeps</i>
<i>Ravenelia</i>	
<i>atrides</i>	<i>Grewia bicolor</i> , <i>G. caffra</i> , <i>G. monticola</i> , <i>G. occidentalis</i> , <i>Grewia</i> spp.
<i>baumiana</i>	<i>Senna petersiana</i> , <i>S. sinqueana</i>
<i>bottomleyae</i>	<i>Albizia versicolor</i>
<i>deformans</i>	<i>Acacia</i> spp.

TABLE 2.—Alphabetical list of rusts with hosts (continued)

Name	Hosts
<i>Ravenalia</i> cont.	
<i>dichrostachydis</i>	<i>Dichrostachys cinerea</i> subsp. <i>nyassana</i>
<i>elephantorrhizae</i>	<i>Elephantorrhiza elephantina</i>
<i>escharoides</i>	<i>Acacia burkei</i> , <i>A. nigrescens</i> , <i>Faidherbia albida</i>
<i>evansii</i>	<i>Acacia gerrardii</i> , <i>A. rehmanniana</i> , <i>A. robusta</i> subsp. <i>robusta</i> , <i>A. sieberiana</i> var. <i>woodii</i> , <i>Acacia</i> spp.
<i>glabra</i>	<i>Calpurnia aurea</i> subsp. <i>sylvatica</i>
<i>halsei</i>	<i>Acacia ataxacantha</i>
<i>indigoferae</i>	<i>Indigofera</i> sp.
<i>inornata</i>	<i>Acacia karroo</i>
<i>le-testui</i>	<i>Cassia</i> sp.
<i>macowaniana</i>	<i>Acacia karroo</i>
<i>minima</i>	<i>Albizia gummifera</i>
<i>modesta</i>	<i>Acacia hebeclada</i> subsp. <i>hebeclada</i> , <i>A. luederitzii</i> var. <i>retinens</i>
<i>natalensis</i>	<i>Acacia karroo</i>
<i>peglerae</i>	<i>Acacia caffra</i>
<i>pianaarii</i>	<i>Acacia caffra</i>
<i>pretoriensis</i>	<i>Acacia</i> spp.
<i>stictica</i>	<i>Mundulea sericea</i>
<i>tephrosiae</i>	<i>Tephrosia heckmanniana</i> , <i>T. macropoda</i> var. <i>macropoda</i>
<i>transvaalensis</i>	<i>Acacia mellifera</i> subsp. <i>detinens</i>
<i>woodii</i>	Fabaceae undet.
<i>Schroeteriaster</i>	
<i>doidgeae</i>	<i>Croton gratissimus</i> var. <i>gratissimus</i>
<i>stratosus</i>	<i>Croton sylvaticus</i>
<i>Skierka robusta</i>	<i>Rhoicissus rhomboidea</i>
<i>Sphaerophragmium</i>	
<i>artabotrydis</i>	<i>Artabotrys monteiroae</i>
<i>dalbergiae</i>	<i>Dalbergia armata</i> , <i>Dalbergia</i> sp.
<i>Tranzschelia discolor</i>	<i>Prunus armeniaca</i> , <i>P. persica</i> , <i>P. salicina</i>
<i>Uredinopsis pteridis</i>	<i>Pteridium aquilinum</i>
<i>Uromycladium tepperianum</i>	<i>Acacia mearnsii</i> , <i>A. saligna</i>
<i>Uropyxis</i>	
<i>gerstneri</i>	Annonaceae undet.
<i>steudneri</i> var. <i>rhodesica</i>	<i>Ormocarpum trichocarpum</i>

TABLE 3.—Alphabetical list of hosts

<i>Acacia</i>
<i>ataxacantha</i> DC.
<i>burkei</i> Benth.
<i>caffra</i> (Thunb.) Willd.
<i>gerrardii</i> Benth. var. <i>gerrardii</i>
<i>hebeclada</i> DC. subsp. <i>hebeclada</i>
<i>karroo</i> Hayne
<i>luederitzii</i> Engl. var. <i>retinens</i> (Sim) J.H. Ross & Brennan
<i>mearnsii</i> De Wild.
<i>mellifera</i> (Vahl) Benth. subsp. <i>detinens</i> (Burch.) Brennan
<i>nigrescens</i> Oliv.
<i>rehmanniana</i> Schinz
<i>robusta</i> Burch. subsp. <i>robusta</i>
<i>saligna</i> (Labill.) Wendl.
<i>sieberiana</i> DC. var. <i>woodii</i> (Burt Davy) Keay & Brennan
spp.
<i>Agrimonia</i>
<i>bracteata</i> E. Mey. ex C.A. Mey.
<i>procera</i> Wallr.
<i>Albizia</i>
<i>gummifera</i> (J.F. Gmel.) C.A. Sm.
<i>versicolor</i> Welw. ex Oliv.
<i>Ancylanthos fulgides</i> Welw.
Annonaceae undet.
<i>Artabotrys monteiroae</i> Oliv.
<i>Calpurnia aurea</i> (Aiton) Benth. subsp. <i>sylvatica</i> (Burch.) Brummitt
<i>Canthium</i>
<i>ciliatum</i> (Klotzsch) Kuntze
<i>mundianum</i> Cham. & Schltdl.
<i>orbiculare</i> Good
spp.
<i>Cassia</i> sp.
<i>Cheilanthes viridis</i> (Forssk.) Sw. var. <i>viridis</i>
<i>Clematis</i>
<i>brachiata</i> Thunb.

<i>oweniae</i> Harv.
<i>Clerodendrum</i>
<i>glabrum</i> E. Mey. var. <i>glabrum</i>
sp.
<i>Coffea arabica</i> L.
<i>Croton</i>
<i>gratissimus</i> Burch. var. <i>gratissimus</i>
<i>sylvaticus</i> Hochst.
<i>Dalbergia</i>
<i>armata</i> E. Mey.
sp.
<i>Dichrostachys cinerea</i> (L.) Wight & Arn. subsp. <i>nyassana</i> (Taub.)
Brenan
<i>Dissotis</i>
<i>incana</i> (Naudin) Triana
<i>longicaudata</i> Cogn.
<i>princeps</i> (Kunth) Triana var. <i>princeps</i>
<i>Duchesnea indica</i> (Andrews) Focke
<i>Elephantorrhiza elephantina</i> (Burch.) Skeels
<i>Euclea</i>
<i>lanceolata</i> E. Mey.
<i>natalensis</i> A. DC. subsp. <i>natalensis</i>
<i>schimperi</i> (A. DC.) Dandy subsp. <i>schimperi</i>
<i>Euphorbia</i>
<i>helioscopia</i> L.
<i>heterophylla</i> L.
<i>kraussiana</i> Bernh. var. <i>kraussiana</i>
<i>striata</i> Thunb. var. <i>striata</i>
spp.
Fabaceae undet.
<i>Fadogia</i>
<i>cienkowski</i> Schweinf.
<i>tetraquetra</i> Krause var. <i>tetraquetra</i>
sp.
<i>Faidherbia albida</i> (Delile) A. Chev.
<i>Ficus</i>
<i>carica</i> L.
<i>cordata</i> Thunb. subsp. <i>salicifolia</i> (Vahl) C.C. Berg.
<i>Gardenia</i>
<i>volkensii</i> K. Schum. subsp. <i>volkensii</i> var. <i>volkensii</i>
<i>thunbergia</i> Thunb.
<i>Gossypium</i> sp.
<i>Grewia</i>
<i>bicolor</i> Juss.
<i>caffra</i> Meisn.
<i>monticola</i> Sond.
<i>occidentalis</i> L.
spp.
<i>Helichrysum</i> sp.
<i>Hewittea sublobata</i> (L. f.) Kuntze
<i>Hypericum</i>
<i>aethiopicum</i> Thunb. subsp. <i>aethiopicum</i>
<i>aethiopicum</i> Thunb. subsp. <i>sonderi</i> (Bredell) N. Robson
<i>lalandii</i> Choisy
<i>Indigofera</i> sp.
<i>Kohautia amatymbica</i> Eckl. & Zeyh.
<i>Linum</i>
<i>africanum</i> L.
<i>usitatissimum</i> L.
<i>Melinis repens</i> (Willd.) Zizka subsp. <i>repens</i>
<i>Milletia grandis</i> (E. Mey) Skeels
<i>Mundulea sericea</i> (Willd.) A. Chev.
<i>Oldenlandia</i> sp.
<i>Ormocarpum trichocarpum</i> (Taub.) Engl.
<i>Pachystigma</i>
<i>latifolium</i> Sond.
<i>pygmaeum</i> (Schltr.) Robyns
<i>Polypodium lycopodioides</i> L.
<i>Populus</i>
<i>alba</i> L.
<i>deltoides</i> Marshall
<i>nigra</i> L. var. <i>italica</i>
<i>wislizenii</i> Sarg.
spp.
<i>Prunus</i>
<i>armeniaca</i> L.
<i>persica</i> (L.) Batsch
<i>salicina</i> Lindl.
<i>Psydrax livida</i> (Hiern) Bridson
<i>Pteridium aquilinum</i> (L.) Kuhn
<i>Pygmaeothamnus</i>
<i>pygmaeum</i> (Schltr.) Robyns
<i>zeyheri</i> (Sond.) Robyns var. <i>zeyheri</i>
<i>Rhamnus prinoides</i> L'Hér.

TABLE 3.—Alphabetical list of hosts (continued)

Rhoicissus rhomboidea (E. Mey. & Harv.) Planch.
Ricinus communis L.
Rosa spp.
Rubus
apetahus Poir.
ludwigii Eckl. & Zeyh. subsp. *ludwigii*
pinnatus Willd.
rigidus Sm.
transvaaliensis Gust
ursinus Cham. & Schldtl.
Rumohra adiantiforme (G. Forst.) Ching
Salix
babylonica L.
mucronata Thunb. subsp. *capensis* (Thunb.) Immelman
spp.
Securinea virosa (Roxb. ex Willd.) Pax & K. Hoffm.
Senna
petersiana (Bolle) Lock
sinqueana (Delile) Lock
Tephrosia
heckmanniana Harms
macropoda (E. Mey.) Harv. var. *macropoda*
Tricalysia
capensis (Meisn. ex Hochst.) Sim var. *capensis*
sonderiana Hiern
Vangueria infausta Burch. subsp. *infausta*
Vangueriopsis lanciflora (Hiern) Robyns ex Good
Vernonia colorata (Willd.) Drake subsp. *colorata*
Ziziphus
mucronata Willd. subsp. *mucronata*
spp.

Botanical Institute (Gibbs Russell *et al.* 1985, 1987, 1988;
 De Wet *et al.* 1990; Arnold & De Wet 1993).

All publications are listed in which references to rusts collected in South Africa have been traced. However, references to the original descriptions of species first described from other countries have been omitted. No attempt has been made to give a complete bibliography of literature on the South African rusts.

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CHECKLIST OF RUST FUNGI RECORDED IN SOUTH AFRICA

Host species are listed in italics.

Names of authors of plant names follow Brummitt & Powell (1992). All collection numbers given (followed by locality) are PREM numbers (PREM: National Collection of Fungi), unless preceded by one of the following codes:

S.A.M.: fungus specimens from the South African Museum Herbarium, now incorporated in PREM;

Stell.: specimens from the Mycological Herbarium of the former Stellenbosch-Elsenburg College of Agriculture, now incorporated in PREM;

Van der Byl: specimens from the P.A. van der Bijl Herbarium, now housed at PREM.

Numbers given in square brackets are duplicate numbers for the preceding specimen.

Other codes used:

- * specimens cited in Doidge (1950) which could not be located;
- ** specimens previously recorded for South Africa which fall outside the geographical area of this publication;
- new species record;
- + type specimen;
- = synonym.

MELAMPSORACEAE

GENUS COLEOSPORIUM

- clematidis** Barclay, P. Syd. & Syd. (1915); Doidge (1927, 1950); Dietel (1928); Doidge et al. (1953); G.J.M. Gorter (1981)
= *Caecoma clematidis* Thüm.
= *Uredo clematidis* Berk.
Clematis brachiata Thunb.: 1861 Barberton; 2359 Kentani; 4383, 10160, 20788, 20795 Somerset East; 10580 Natal
Clematis oweniae Harv.: 801, 10581, 11223, 31906* Inanda
hedytidis Kalchbr. & Cooke (1880); Sacc. (1888); P. Syd. & Syd. (1915); Doidge (1927, 1950); G.J.M. Gorter (1981)
Kohautia amatymbica Eckl. & Zeyh.: 36, 1256, 1419, 1456, 2194, 6600, 8908, 9692, 23369, 30944 Pretoria; 8910 Bethlehem; 10067 Mooi River; 10156+ Inanda; 14171 without locality; 40997 East Griqualand
Oldenlandia sp.: 32706 Natal

- ipomoeae** (Schwein.) Burrill, Doidge (1927, 1950); G.J.M. Gorter (1981)
Hewittea sublobata (L. f.) Kuntze: 1598, 2501, 9100 Winkle Spruit; 6633* Isipingo; 9479 Inanda; 12334 Durban

GENUS CRONARTIUM

- gilgianum** Henn., Sacc. & P. Syd. (1890); P. Syd. & Syd. (1915); Syd. & P. Syd. (1918); Doidge (1927, 1950); Nel (1942)
= *Cronartium bresadolanum* Henn.
= *Crossopora gilgiana* (Henn.) Syd.
= *Cronartium bresadolanum* Henn. var. *euclaea*

- Euclaea lanceolata* E. Mey.: 1737, 1738, 1739 Soutpansberg
Euclaea natalensis A.D.C. subsp. *natalensis*: 1606, 1617, 2415, 9496, 32442 Durban; 2509 Winkle Spruit; 6646 Isipingo; 9089, 9115 Kentani; 10630 Natal; 12420 East London; 26006, 32399, 33601 Nelspruit; 22417 Alexandria; 32273 Kruger National Park; 32410 Sabie; 33487, 35159, 43119 Grahamstown; 33527 Mtunzini; 33597 Entabeni; 41032 Umtentweni
Euclaea schimperi (A. DC.) Dandy subsp. *schimperi*: 12170** [Van der Byl 1803]; 729 Nelspruit; 1151, 1852, 5620, 18097 Barberton; 1399 Winkle Spruit; 30959, 30960 Kruger National Park

zizyphi Syd. & E.J. Butler, Doidge (1927, 1950)

- Ziziphus mucronata* Willd. subsp. *mucronata*: 32724 between Acornhoek and Tzaneen; 41983 Lydenburg
Ziziphus spp.: 50573 Ellisras; 50576 Nelspruit; 50696 Kruger National Park

GENUS MELAMPSORA

acidioides (see *M. populnea*)

allii-populina* Kleb.

- Populus deltoides* Bart. ex Marshall: 43192 Pretoria

coleosporioides* Dietel

- Salix babylonica* L.: 50566 Grabouw; 50568, 50569 Stellenbosch

helioscopiae G. Winter, Doidge (1927, 1950); G.J.M. Gorter (1981)

- Euphorbia helioscopia* L.: 41453 Pretoria
Euphorbia heterophylla L.: 29876, 30979, 32278 Pretoria; 32206 Durban; 33603 Natal; 40167 Tzaneen
Euphorbia kraussiana Bernh. var. *kraussiana*: 9087 Claridge

Euphorbia striata Thunb. var. *striata*: 17035 Mooi River; 29720 Pretoria

Euphorbia spp.: 1065 Bethlehem; 1851 Barberton

Euphorbia heterophylla L.: 420711, 44620 Pretoria

hypericorum G. Winter var. *australis* Doidge (1927, 1950); G.J.M. Gorter (1981)

= *Melampsora hyperici* J. Schröt.

Hypericum aethiopicum Thunb. subsp. *aethiopicum*: 30079* Hogsback

Hypericum aethiopicum Thunb. subsp. *sonderi* (Bredell) N. Robson:

1074 Lydenburg, 1302, 1946, 1988, 9314, 9480*, 9691, 32090*

Pretoria; 10361 Inanda; 12241 Mooi River

Hypericum lalandii Choisy: 10362 Natal

junodii** Doidge (1927, 1950)

Vernonia colorata (Willd.) Drake subsp. *colorata*: 11723+

larici-populina* Kleb., G.J.M. Gorter (1979, 1982)

= *Melampsora populina* (Jacq.) Lévy

Populus deltoides Marshall: 43691 Pietermaritzburg; 43694 Pretoria

Populus nigra L. var. *italica*: 43730 George; 43732 Nelspruit; 43833

Pretoria; 48510 Harding

Populus wislizenii Sarg.: 43731 George

Populus spp.: 43692, 47995 Pietermaritzburg; 43911, 50565 Pretoria;

47559 Stellenbosch; 48496 Witbank; 48497 Bethal; 48511

Greytown

lini (Ehrenb.) Lévy, Verwoerd (1929); Nel (1942); Doidge (1950); Doidge et al. (1953); G.J.M. Gorter (1977, 1981)

Linum africanum L.: 46119 (Stell. 150) Stellenbosch

*Linum usitatissimum** L.

medusae* Thüm., T.N. Trench, A.P. Baxter & H. Churchill (1988)

= *Melampsora albertensis* Arthur

= *Uredo medusae* (Thüm.) Arthur

Populus deltoides Marshall: 48253, 50554, 50555, 50556, 50557 Grey-

town; 48329 Ermelo; 48330 Howick; 48331 Pietermaritzburg;

48332 Piet Retief

Populus sp.: 48499 Vryheid

populnea (Pers.) P. Karst., G.J.M. Gorter (1977)

= *Melampsora aecidioides* J. Schröt.

Populus alba L.: 537 Cape Town; 7102 Soutpansberg; 23723, 44353

Pretoria

Populus spp.: 639 Cape Town; 711 Groot Drakenstein; 724 Cape; 733

Inchanga; 1514 Wellington; 21936 Bloemfontein; 29859 Sout-

pansberg; 30780 Rustenburg; 32141**, 34319, 34419, 36791

Pretoria; 45985 (Stell. 24), 46795 (Stell. 879) Stellenbosch

puccinioides* G. Winter (1885); Sacc. (1888); P. Syd. & Syd. (1915); Doidge (1950)

Helichrysium sp.

ricini Pass., P. Syd. & Syd. (1915); Van der Byl (1926); Doidge (1927, 1950); Doidge & Bottomley (1931); Nel (1942); Doidge et al. (1953); G.J.M. Gorter (1977)

= *Caeoma ricini* Schltdl.

= *Uredo ricini* Biv.

= *Melampsorella ricini* (Biv.) De Toni

= *Uromyces ricini* Biv.

Ricinus communis L.: 55, 7402, 14203, 30968*, 30969 Pretoria; 179

Soutpansberg; 524**, 738 Kenilworth; 1013, 20778 Graham-

stown; 10161 Inanda; 10163, 20783, 20789 Somerset East;

11505 Buffelspoort; 23363 Boulders; 32300 Durban; 32309

Eshowe; 45988 Stellenbosch

vitellinae Thüm., Doidge (1927, 1950); G.J.M. Gorter (1981, 1982).

= *Uredo mixta* Duby forma *salicis-capensis* Thüm.

= *Melampsora mixta* (Schltdl.) J. Schröt.

Salix mucronata Thunb. subsp. *capensis* (Thunb.) Immelman: 923

Boshoff; 20766* (S.A.M. 33935) Somerset East; 50505 Betty's

Bay

Salix spp.: 45875 Grahamstown; 50492, 50753 Royal Natal National

Park; 50656 Pretoria

GENUS MILESINA

dieteliana (Syd.) Magnus, P. Syd. & Syd. (1915); Doidge (1927, 1950)

= *Milesia polypodii* F.B. White

= *Melampsorella dieteliana* Syd.

Polypodium lycopodioides L.: 1634 Amanzimtoti

nervisequa (Syd.) Faull, P. Syd. & Syd. (1915); Doidge (1927, 1950)

= *Milesia nervisequa* Syd.

= *Caeoma nervisequum* Thüm.

sub *Uredo filicium* Klotzsch

sub *Uredo polypodii* (Pers.) DC.

Cheilanthes viridis (Forssk.) Sw. var. *viridis*: 999 Pretoria; 1370 Dur-

ban; 1836 Soutpansberg; 10162 Natal; 20781 Somerset East

*Rumohra adiantiforme*** (G. Forst.) Ching: S.A.M. 28729

GENUS PUCCINIASTRUM

agrimoniae (Dietel) Tranzschel, P. Syd. & Syd. (1915); Doidge (1927, 1950); Dietel (1928)

= *Coleosporium ochraceum* Fuckel

sub *Phragmidium obtusum* C. Tul.

Agrimonia bracteata E. Mey. ex C.A. Mey.: 303 Fort Beaufort; 332

Inanda; 1150, 1202, 1261, 1407, 2147, 6655, 29771, 29814,

29847 Pretoria; 2313 Harrismith; 2353 Kentani; 32284 without

locality; 11638 Lidgetton; 11649 Tweedie; 24351, 20323 Sout-

pansberg; 10157*, 10158, 20777, 20797 Somerset East; 25977

Barberton; 32311 Natal

Agrimonia procera Wallr.: 50762 Cathkin Park, 50731 Uitsoek State Forest

GENUS UREDINOPSIS

macrosperma (see **U. pteridis**)

pteridis Dietel & Holw.

= *Uredinopsis macrosperma* (Cooke) Magnus

Pteridium aquilinum (L.) Kuhn: 10590, 11224 Inanda

PUCCINIACEAE

GENUS CEROTELIUM

fici (Castagne) Arthur, Verwoerd (1929); Doidge (1950); Doidge et al. (1953)

= *Kuehneola fici* E.J. Butler

= *Uredo fici* Castagne

= *Physopella fici* Arthur

Ficus carica L.: 289 Grahamstown; 615 Constantia; 852 Pieter-

maritzburg; 1207, 25159 Cape; 20726* Cape Town; 1315

Renosterfontein; 46129 [Stell. 161], 46799 [Stell. 882] Stellen-

bosch

Ficus cordata Thunb. subsp. *salicifolia* (Vahl) C.C. Berg: 176, 1298

Pretoria

gossypii (see **Phakopsora desmum**)

GENUS DIORCHIDIUM

tricholaenae Syd., Syd. & P. Syd. (1912); Sacc. & Trotter (1925); Doidge (1927, 1950); Doidge & Bottomley (1931)

Melinis repens (Willd.) Zizka subsp. *repens*: 269*+, 586 Barberton;

1449 Harden Heights, 1605, 2393, 2512 Winkle Spruit; 1607,

1608 Amanzimtoti; 20631 Natal; 30138 Nelspruit; 30292

Ndwedwe; 30974 Estcourt

woodii Kalchbr. & Cooke in Kalchbr. (1882); Sacc. (1888); Magnus (1891); Doidge (1927, 1950); Dietel (1928); Doidge & Bottomley (1931)

= *Puccinia woodii* (Kalchbr. & Cooke) Syd.

Milletia grandis (E. Mey.) Skeels: 335+, 10448+, 10449+, 22090 Ton-

gaat; 1593, 1978, 2515 Winkle Spruit; 1601 Amanzimtoti, 5606

Port Shepstone; 11893 Umkomaas

GENUS ENDOPHYLLUM

macowanii Pole Evans (1907, 1908); P. Syd. & Syd. (1924); Van der Byl (1925, 1926); Doidge (1927, 1950); Nel (1942)

= *Aecidium elegans* Dietel

= *Aecidium rhanii* Pers. forma *rhanii-prinoides*

sub *Puccinia coronata* Corda

Rhamnus prinoides L'Hér.: 379, 17114 George; 1772, 17738, Sout-

pansberg; 2097 Kentani; 2418, 17215 Knysna; 4275, 20735,

20761 Somerset East; 33152 Donnybrook

GENUS FROMMEA

obtusaduchesneae* (Arthur) Arthur

= *Frommea obtusa* (F. Strauss) Arthur

= *Frommea obtusa* (F. Strauss) Arthur var. *duchesneae* Arthur

Duchesnea indica (Andrews) Focke: 48512 Greytown; 48609, 48610

Pretoria; 50482 Cathkin Park

obtusa var. duchesneae (see **F. obtusa-duchesneae**)

GENUS HAMASPORA

longissima (Thüm.) Körn. (1877); Massee (1892); P. Syd. & Syd. (1915); Doidge (1927, 1950); Dietel (1928); Doidge & Bottomley (1931); Doidge et al. (1953)

= *Uredo lucida* Thüm.

= *Phragmidium longissimum* Thüm.

Rubus ludwigii Eckl. & Zeyh. subsp. *ludwigii*: 9776 Spitskop; 27562 between Kestell and Clarens; 32303 Durban

Rubus pinnatus Willd.: 1620 Winter's Kloof; 2350 Kentani; 2404 Cramond; 30375 Donnybrook

Rubus rigidus Sm.: 144, 1825 Soutpansberg; 2351 Kentani; 5161 Komgha; 8387 Pretoria; 10589, 11055, 11205 Inanda; 20721, 20723*, 20742*, 20746* [S.A.M. 28746] Somers East; 22413 East London; 26051 Barberton; 32741 Rustenburg

Rubus transvaaliensis Gust: 1267, 1379*, 1380, 1513, 1535*, 1891*, 1914, 1949, 2184, 6656, 6657, 6898, Pretoria; 20333 Soutpansberg; 26016 Barberton

Rubus spp.: 29753 Pretoria; 33385 Grahamstown; 46490 [Stell. 561] Cape Town; 46955 [Stell. 1033] Stellenbosch; 50489 Cathkin Park

GENUS HEMILEIA

ancylanthi** Syd., P. Syd. & Syd. (1915); Doidge (1927, 1950)

= *Uredo ancylanthi* Henn.

Ancylanthos fulgides Welw.

canthii Berk. & Broome, P. Syd. & Syd. (1915); Doidge (1927, 1950); G.J.M. Gorter (1981)

= *Coleosporium detergibile* Thüm.

= *Uredo detergibilis* Henn.

Canthium ciliatum (Klotzsch) Kuntze: 20779, 33918 [S.A.M. 33918] Somers East

Canthium mundianum Cham. & Schltdl.: 50861 Sandton

*Canthium orbiculare*** Good

Canthium sp.: 9084 Wyebank

*Psyrax livida*** (Hiern) Bridson

evansii Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915), Sacc. & Trotter (1925), Doidge (1927, 1950)

Tricalysia sonderiana Hiern: 6635 Umbogintwini

Tricalysia capensis (Meisn. ex Hochst.) Sim. var. *capensis*: 590**

fadogiae Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915), Sacc. & Trotter (1925); Doidge (1927, 1950); G.J.M. Gorter (1981)

Fadogia cienkowski Schweinf.: 757**, 7391 Nelspruit

Fadogia tetraquetra Krause var. *tetraquetra*: 34482 Pietersburg

*Fadogia*** sp.

Pygmaeothamnus pygmaeum (Schltr.) Robyns: 48608 Nelshoogte State Forest

Pygmaeothamnus zeyheri (Sond.) Robyns var. *zeyheri*: 281+ Heidelberg; 2209, 12229, 26376, 34218 Pretoria; 21232 Newcastle; 28811* Waterberg; 42421 Welverdiend

gardeniae-thunbergiae* Maubl. & Roger

*Gardenia thunbergia*** Thunb.

Gardenia volkensii K. Schum. subsp. *volkensii* var. *volkensii*: 50708 Kruger National Park

*Gardenia** sp.

scholzii Syd., Syd. & P. Syd. (1910); P. Syd. & Syd. (1915); Doidge (1927, 1950)

= *Uredo scholzii* Henn.

Clerodendrum glabrum E. Mey. var. *glabrum*: 1569, 1570 Amanzimtoti
*Clerodendrum*** sp.

vastatrix Berk. & Broome, J.M. Wood (1883, 1906); P. Syd. (1899); Burt Davy (1904); Pole Evans (1907); P. Syd. & Syd. (1915); Van der Byl (1926); Doidge (1927, 1950); Doidge & Bottomley (1931); G.J.M. Gorter (1977, 1981)

= *Uredo gardeniae-thunbergiae* Henn.

Coffea arabica L.: 5, 42, 59, 172, 20322 Tzaneen; 323, 349 Natal; 372 Durban; 409 Pretoria; 991 Lemana; 1403 Winkle Spruit; 6824, 7788 Verulam; 20857 Rietveld; 21933 Lydenburg; 23142 Louis Trichardt; 23498 Potchefstroom; 24344* Duiwelskloof; 24941 Pinetown; 25469, 30936* Umbogintwini

woodii Kalkb. & Cooke (1880); Sacc. (1888); Burt Davy (1904); J.M. Wood (1906); Pole Evans (1907); P. Syd. & Syd. (1915); Van der Byl (1926); Doidge (1927, 1950); Nel (1942); G.J.M. Gorter (1981)

= *Uredo vangeriae* Cooke

Pachystigma latifolium Sond.: 173 without locality; 340, 10600, 11185 Inanda; 814, 10549, 10599*, 32021* Natal; 1404, 5640 Winkle Spruit; 6835 Scottburgh; 8250 Krantzklouf; 9762 New Hanover; 14177 Entumeni; 24940 Brighton Beach

Pachystigma pygmaeum (Schltr.) Robyns: 30909 White River

Vangueria infausta Burch. subsp. *infausta*: 324, 352, 10410 Natal; 1154, 1277, 1278 Barberton; 1679 Table Mountain; 1815 Soutpansberg; 2446 Cramond; 2497 Winkle Spruit; 11845 Louis Trichardt; 14104*; 30941 Inanda; 32403, 50733 Nelspruit

*Vangueriopsis lanciflora*** (Hiern) Robyns ex Good

GENUS KUEHNEOLA

albida (see **K. uredinis**)

uredinis (Link) Arthur, G.J.M. Gorter (1977, 1981)

= *Kuehneola albida* (J.G. Kühn) Magnus

Rubus apetalus Poir.: 1532 Lydenburg

Rubus rigidus Sm.: 1863 Barberton; 32287 without locality

Rubus transvaaliensis Gust: 642 Barberton; 992 Wellington; 2417 Knysna; 33173 Pietermaritzburg

Rubus ursinus Cham. & Schltdl.: 46001 Stellenbosch [Stell. 39; Van der Byl 1101]. This specimen was previously wrongly identified as *Phragmidium violaceum* (C.F. Schultz) G. Winter.

Rubus spp.: 681 Cape Town; 6931 Stellenbosch; 18087 Pretoria; 32125 Knysna; 50483 Cathkin Park

GENUS MASSEEELLA

flueggeae Syd., Doidge (1939, 1950); G.J.M. Gorter (1981)

= *Uredo brideliae* (Henn. & Pole Evans) Doidge

= *Aecidium brideliae* Henn. & Pole Evans

Securinea virosa (Roxb. ex Willd.) Pax & K. Hoffm.: 77 Nelspruit; 25968, 26359 Barberton

GENUS PHAKOPSORA*

desmium (see **P. gossypii**)

gossypii (Arthur) Hirats. f., Cummins (1962)

= *Phakopsora desmium* (Berk. & Broome) Cummins

Gossypium sp.: 23190 Natal

GENUS PHRAGMIDIUM

disciflorum (see **P. mucronatum**)

mucronatum Fr.

= *Phragmidium disciflorum* (Tode) J. James

Rosa spp.: 139 Kimberley; 141, 1171, 1212, 1892, 32830 Pretoria; 421 Bloemfontein; 484**; 787* Durban; 1866 Wellington; 2430 Uniondale; 9310 Kentani; 15041* Port Elizabeth; 28521 Fort Beaufort; 34257**; 46022 Stellenbosch

violaceum (R. Schultz) G. Winter (This specimen was wrongly identified and is now filed under *Kuehneola uredinis*. *Phragmidium violaceum* has not been collected in South Africa.)

GENUS PUCCINIOSIRA

dissotidis* Wakef., P. Syd. & Syd. (1924); Doidge (1927, 1950)

= *Aecidium dissotidis* Cooke

= *Uredo dissotidis* Cooke, l.c.

= *Uredo dissotidis-longicaudae* Henn.

Dissotis incana (Naudin) Triana: 10288, 11194 Natal

*Dissotis longicaudata*** Cogn.

Dissotis princeps (Kunth) Triana var. *princeps*: 10289 Natal

GENUS RAVENELIA

atrides Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915); Dietel (1928); Sacc. & Trotter (1925); Doidge (1927, 1948, 1950)

= *Dasturella atrides* Thürom.

Grewia bicolor Juss.: 32731 Kruger National Park

Grewia caffra Meisn.: 1630, 1670+, 2534 Durban

Grewia monticola Sond.: 32401 Nelspruit

Grewia occidentalis L.: 1629 Amanzimtoti

Grewia spp.: 5075, 5076 Kruger National Park

baumiana Henn. (1903); Dietel (1906); Sacc. & D. Sacc. (1905); P. Syd. & Syd. (1915); Doidge (1927, 1948, 1950)

= *Haploravenelia baumiana* (Henn.) Syd.

Senna petersiana (Bolle) Lock: 29870 Rooiwal; 30955 Schagen; 32404 Nelspruit; 50553 Hanglip State Forest

Senna singuana (Delile) Lock: 6886**+

- bottomleyae**** Doidge (1927, 1950)
Albizia versicolor Welw. ex Oliv.: 14166
- deformans**** (Maubl.) Dietel (1906); P. Syd. & Syd. (1915); Sacc. & Trotter (1912); Doidge (1927, 1950)
= *Pleoravenelia deformans* Maubl.
= *Cystingophora deformans* (Maubl.) Syd.
Acacia sp.
- dichrostachydis** Doidge (1927, 1950)
Dichrostachys cinerea (L.) Wight. & Arn. subsp. *nyassana* (Taub.) Brenan: 6806, 7106 Verulam
- elephantorrhizae** Doidge (1927, 1950)
Elephantorrhiza elephantina (Burch.) Skeels: 8955+, 12225, 12841, 23453 Pretoria; 23359 Enselberg; 29732* Donkerpoort
- escharoides** Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915); Sacc. & Trotter (1925); Doidge (1927, 1950); G.J.M. Gorter (1981)
*Faidherbia albida*** (Delile) A. Chev.
Acacia burkei Benth.: 534+ Potgietersrus; 10086 Springbok Flats; 20654 Naboomspruit; 27586 Hartbeespoort; 29918 Pienaar's River; 50690 Kruger National Park
Acacia nigrescens Oliv.: 50691, 50695 Kruger National Park
- evansii** Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915); Sacc. & Trotter (1925); Doidge (1927, 1939, 1950); G.J.M. Gorter (1981)
= *Dendroecia evansii* Syd.
Acacia gerrardii Benth. var. *gerrardii*: 30127 Verulam
Acacia rehmanniana Schinz: 5625 Pretoria
Acacia robusta Burch. subsp. *robusta*: 123, 149, 2181+, 2212, 5175, 6588, 6698, 14144 Pretoria; 1316 Magalies River; 6807, 7105 Verulam; 18085 Loskop; 28954 Magaliesberg; 29933 Wolmaransstad; 30124 Umzinto; 50693 Kruger National Park
Acacia sieberiana DC. var. *woodii* (Burr Davy) Keay & Brenan: 2539+ Estcourt
Acacia spp.: 2403 Cramond; 11670 Pretoria; 33171 Johannesburg
- glabra** Kalchbr. & Cooke (1880), Cooke (1880); Dietel (1894, 1906); P. Syd. & Syd. (1915); Doidge (1927, 1950)
sub *Ravenelia stictica* Berk. & Broome
Calpurnia aurea (Aiton) Benth. subsp. *sylvatica* (Burch.) Brummitt: 2320, 2330, 5165 Kentani; 2375+, 10696+, 10698+, 20728+, 20732+, 20727, 20728*+, 20851 [S.A.M. 28754] Somerset East
- halsei** Doidge (1939, 1950)
Acacia ataxacantha DC.: 30117+ Ndwedwe; 50571, 50748 Nelspruit
- indigoferae**** Tranzschel, Dietel (1894); P. Syd. & Syd. (1915); Doidge (1927, 1950)
sub *Ravenelia laevis* Dietel & Holw.
Indigofera sp. 15513 Harare, Zimbabwe
- inornata** Dietel (1894, 1906); Sacc. (1895); P. Syd. & Syd. (1915); Doidge (1927, 1950); G.J.M. Gorter (1981)
= *Aecidium inornatum* Kalchbr.
= *Cystoteliium inornatum* (Dietel) Syd.
= *Haploravenelia inornata* Dietel
Acacia karroo Hayne: 2368 Kentani; 2377+, 4262*+, 20734+ Somerset East; 2368*, 2541 Komgha; 22375 Kirkwood; 26396 Grahamstown
- le-testui**** Maubl., Dietel (1906); Sacc. & Trotter (1912); P. Syd. & Syd. (1915); Doidge (1927, 1950)
Cassia sp.
- macowaniana** Pazschke, Dietel (1894, 1928); Sacc. (1895); P. Syd. & Syd. (1915); Doidge (1927, 1948, 1950); G.J.M. Gorter (1981)
= *Aecidium ornamentale* Kalchbr.
= *Ravenelia ornamentalis* Dietel
= *Cephateliium macowanianum* (Pazschke) Syd.
Acacia karroo Hayne: 329, 834*, 10299, 13074 Ladysmith; 929 Leeuwardens; 1417 Kroonstad; 1524, 2123, 21224, 21225, 23449, 23452, 1985, 2095, 2170, 11857, 2255, 2447, 6665, 23203, 23452*, 24913, 28603, 29817, 29798*, 29916, 30912, 36935, 47473, 50686, 50687, 50688, 50692, 50697, 50701, 50699, 50700, 50711 Pretoria; 1915, 8757 Kentani; 2077 Indwe; 2135 Plat River; 2355 Zwartfontein; 2357, 5154 Vryheid; 2376+, 4067+, 20730+, 20731+, 20733+ Somerset East; 2423 Trapp's Valley; 2552 Bathurst; 7367* Butterworth, 7404, 28597, 50700 Onderstepoort; 8245 Mudcn; 8857 Queenstown; 10017 Riverton; 11002 Springbok Flats; 11300 Bloemfontein; 15453 Klipplaat; 21052* Asbury; 27585 Hartbeespoort; 28505 Friedenheim; 28606 Prieska; 30327 Wolmaransstad; 30971 Estcourt; 31021 Ventersburg; 34583 Witbank; 40653 Soutpansberg; 44332 Mafikeng; 46145 Knysna; 46208 Oudtshoorn; 47474
- Schweizer Reinecke; 50757, 50758 50759, 50760 Boekenhoutskloof; 50762 Ashton Bay
- minima** Cooke (1882); Sacc. (1888); Dietel (1894, 1906); P. Syd. & Syd. (1915); Doidge (1927, 1950); Doidge & Bottomley (1931); G.J.M. Gorter (1981)
Albizia gunnifera (Gmel.) C.A. Sm.: 351, 10697+ Inanda; 1835*, 1400, 1582, 2384 Winkle Spruit; 6827 Scottburgh; 30779 Durban
- modesta** Doidge (1939, 1948, 1950); G.J.M. Gorter (1981)
Acacia hebeclada DC. subsp. *hebeclada*: 30110+ Pretoria
Acacia hederitzi Engl. var. *retinens* (Sim) J.H. Ross & Brenan: 34572 between Hammanskraal and Pienaar's River
- natalensis** Syd. & Polc Evans, Syd. & P. Syd. (1912); P. Syd. & Syd. (1915); Sacc. & Trotter (1925); Doidge (1927, 1950)
= *Longia natalensis* (Syd. & Pole Evans) Syd.
= *Haploravenelia natalensis* (Syd. & Pole Evans) Dietel
Acacia karroo Hayne: 1584+, 1935+, 2514 Winkle Spruit
- peglerae** Pole Evans (1918); Doidge (1927, 1950); G.J.M. Gorter (1981)
Acacia caffra (Thunb.) Willd.: 2331+, 2367, 5179, 5626 Kentani; 2544* Butterworth; 5150 Weenen
- pienaarrii** Doidge (1927, 1950); G.J.M. Gorter (1981)
Acacia caffra (Thunb.) Willd.: 2449, 5627+, 6658*+, 11508, 23450*, 23448, 23451, 26395, 49454, 51013 Pretoria; 5159 Weenen
- pretoriensis** Syd., Syd. & P. Syd. (1912); P. Syd. & Syd. (1915); Sacc. & Trotter (1925); Doidge (1927, 1939, 1950)
Acacia sp.: 1376+ Pretoria
- stictica** Berk. & Broome, Sacc. & P. Syd. (1890); P. Syd. & Syd. (1915); Doidge (1927, 1950); G.J.M. Gorter (1981)
= *Ravenelia munduleae* Hcnn.
Mundulea sericea (Willd.) A. Chev.: 124, 1522, 13089, 23447, 2210, 2256, 2227, 19842, 29728, 30716, 32667, 41959, 43144, 49376, 50558 Pretoria; 146 Hartbeespoort; 28255 Potgietersrus
- tephrosiae** Kalchbr., Sacc. (1888); Dietel (1894, 1906); P. Syd. & Syd. (1915); Doidge (1927, 1950); G.J.M. Gorter (1981)
*Tephrosia heckmanniana*** Harms
Tephrosia macropoda (E. Mey.) Harv. var. *macropoda*: 10700 Inanda; 14190 Entumeni
- transvaaliensis** Doidge (1939, 1950)
Acacia mellifera (Vahl) Benth. subsp. *detinens* (Burch.) Brenan: 37382+ Pretoria
- woodii**** Pazschke, Dietel (1894); P. Syd. & Syd. (1915); Sacc. (1895); Doidge (1927, 1950)
Fabaceae undet.

GENUS SCHROETERIASTER

doidgeae Syd. (1926); Doidge (1927, 1950)

Croton gratissimus Burch. var. *gratissimus*: 14173 Waterberg

stratosus (Cooke) Syd., P. Syd. & Syd.; Doidge (1927, 1950); Doidge & Bottomley (1931)

= *Melampsora stratosata* Cooke

Croton sylvaticus Hochst.: 363 Natal; 2020, 2383, 2500, 5639 Winkle Spruit; 10363 Inanda; 33093 Eshowe; 35148 Louis Trichardt

GENUS SKIERKA

robusta Doidge (1927, 1950); Mains (1939)

Rhoicissus rhomboidea (E. Mey. ex Harv.) Planch.: 1635+ Durban; 1824 Lemaana; 2398 Winkle Spruit, 2416 Umgeni Beach; 6628 Isipingo; 32781 Umhlanga Rocks; 39125 Southport

GENUS SPHAEROPHRAGMIUM

artabotrydis Doidge (1941, 1950); Monoson (1974)

Artabotrys monteiroae Oliv.: 30761+ Westville

dalbergiae Dietel; Kalchbr. (1882); Sacc. (1895); P. Syd. & Syd. (1915); Doidge (1927, 1950); Monoson (1974)

Dalbergia armata E. Mey: 881*, 2524 Umgeni Lagoon; 1371, 5144 Durban; 6825 Verulam; 30954 Nelspruit; 35147 Empangeni
Dalbergia sp.: 51015 Nelspruit

GENUS UROMYCLADIUM

tepperianum (Sacc.) McAlpine. M.J. Morris, M.J. Wingf. & J. Walker (1988)

Acacia mearnsi De Wild.: 48897 Bainskloof

Acacia saligna (Labill.) J.C. Wendl.: 50659 Stellenbosch

GENUS UROPYXIS

(?)**gerstneri** Doidge (1927, 1950); J.W. Baxter (1959)
Annonaceae undet.: 34564+ Zululand

This is a doubtful species. Examination revealed characters that place this species in the genus *Diorchidium*.

steudneri Magnus var. **rhodesica**** Doidge (1948, 1950); J.W. Baxter (1959)

Ormocarpum trichocarpum (Taub.) Engl.: 34032 Inyati, Zimbabwe

GENUS TRANZSCHELIA•

discolor• (Fuckel) Tranzschel & M.A. Litv.; Nel (1942)

= *Tranzschelia punctata* (Pers.) Arthur

= *Tranzschelia pruni-spinosae* var. *discolor* (Fuckel) Dunegan

= *Puccinia discolor* Fuckel

Prunus armeniaca L.: 5593 Graaff-Reinet; 30966 Pretoria

Prunus persica (L.) Batsch: 1 Elsenburg; 125 without locality; 290, 321 Fort Beaufort; 7800 Pretoria; 45982, 46791 Stellenbosch

Prunus salicina Lindl.: 1250 Lake Chrissie; 1290 Bethal; 2378 Grahamstown; 48612 Pretoria

Studies in the Marchantiales (Hepaticae) from southern Africa. 9. The genus *Marchantia* and its five local species

S.M. PEROLD*

Keywords: distribution, ecology, Hepaticae, *Marchantia*, *M. berteriana*, *M. debilis*, *M. paleacea* subsp. *paleacea*, *M. pappeana* subsp. *pappeana*, *M. polymorpha* subsp. *ruderalis*, southern Africa, taxonomy

ABSTRACT

In this, the ninth and final article in the series on southern African Marchantiales, a taxonomic account is given of the genus *Marchantia* which is locally represented by five species. Two of the three subgenera that are recognized, namely subgenus *Marchantia* (with two species, *M. polymorpha* subsp. *ruderalis* and *M. berteriana*), as well as subgenus *Chlamidium* (Corda) Bischl. which is divided into three sections, namely *Paleaceae* (with *M. paleacea* subsp. *paleacea*), *Chlamidium* (with *M. pappeana* subsp. *pappeana*) and *Papillatae* (with *M. debilis*) are treated. The third subgenus, *Protomarchantia* Schust., is absent from the region. Corrections need to be made to the *Marchantia* species given in Magill & Schelpe's (1979) checklist and in Arnold & De Wet (1993). Descriptions and illustrations of the taxa together with distribution maps, their ecology and a key to the subgenera and species are provided.

Only traditional taxonomic methods were employed and this treatment closely follows that of Bischler-Causse (1993a), the recognized world authority on the group. All southern African specimens held at BOL and PRE, as well as a few from other herbaria have been studied and some new collections have been added. It is shown that *M. polymorpha* subsp. *ruderalis* has been introduced, as it is only known from local nurseries. The presence here of *M. paleacea* subsp. *paleacea* is confirmed, although it is rare. Otherwise little that is new could be added to the exhaustive studies by Bischler-Causse (1993a).

UITTREKSEL

In hierdie, die negende en finale artikel in die reeks oor die Marchantiales van suidelike Afrika, word 'n taksonomiese verslag gegee oor die genus *Marchantia* wat plaaslik deur vyf spesies verteenwoordig word. Twee van die drie erkende subgenusse, nl. subgenus *Marchantia* (met twee spesies, *M. polymorpha* subsp. *ruderalis* en *M. berteriana*) sowel as subgenus *Chlamidium* (Corda) Bischl. wat verdeel word in drie seksies, nl. *Paleaceae* (met *M. paleacea* subsp. *paleacea*), *Chlamidium* (met *M. pappeana* subsp. *pappeana*) en *Papillatae* (met *M. debilis*), word behandel. Die derde subgenus, *Protomarchantia* Schust., kom nie in die gebied voor nie. Regstellings moet aangebring word aan die *Marchantia*-spesies soos aangegee in Magill & Schelpe (1979) se lys en in Arnold & De Wet (1993). Beskrywings en illustrasies van die taksons sowel as verspreidingskaarte, die ekologie en 'n sleutel tot die subgenusse en spesies word verskaf.

Slegs tradisionele taksonomiese metodes is toegepas, en word die werk van Bischler-Causse (1993a), die erkende wêreldgesaghebbende op die groep, word ten nouste nagevolg in hierdie behandeling. Alle eksemplare uit suidelike Afrika in BOL en PRE asook 'n paar van ander herbariums is bestudeer en nuwe versamelings is bygevoeg. Daar word aangetoon dat *M. polymorpha* subsp. *ruderalis* uitheems is, aangesien dit slegs in plaaslike kwekerye voorkom. *M. paleacea* subsp. *paleacea* se teenwoordigheid hier word bevestig, maar dit is skaars. Origens kon min tot die uiters volledige studies deur Bischler-Causse (1993a) bygevoeg word.

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Marchantia L., Species plantarum edn 1: 1137 (1753) emend. Raddi, Opuscoli Scientifica di Bologna: 358 (1818); Sim: 27 (1926); S.W. Arnell: 53 (1963); Bischl.: 6 (1984); Bischl.: 13 (1989a); Bischl.: 13 (1993a); R.M. Schust.: 305 (1992). Type species: *Marchantia polymorpha* L. [lecto. fide Leman: 115 (1823)].

Marchantia M. Marchant f.: 229 (1739).

Marchantiopsis Douin & R.C.V. Douin: 135 (1918).

Chlamidium Corda: 647 (1829).

Thalloid, smallish to medium-sized to large, flat and ungrooved, relatively delicate or firm and occasionally rather leathery, green to dark green or greyish green, along margins sometimes purplish, rarely all over dorsally and occasionally also ventrally; dorsal face with distinct polygonal areolae, each with a pore; in crowded mats, sometimes in partial rosettes, hygrophytes, requiring high humidity and mostly unable to sustain life dry; growing

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MS. received: 1995-03-27.

on damp soil of vertical stream banks, at waterfalls, dams, weirs and canals, sometimes on wet rocks, rarely on rotting wood.

Branches broadly band- or narrowly ribbon-shaped, pseudodichotomously furcate, without lateral or apical innovations from keel, ventrally thickened medianly and tapered toward margins, which are lobulate, crenulate, undulate or entire, apex notched, with median scale appendages recurved over edge. *Dorsal epidermal cells* generally unistratose, often without chloroplasts, walls thin or slightly thickened but lacking trigones; air pores compound, encircled by several superimposed concentric rings of cells, some above epidermis, others projecting into air chambers below, the latter in a shallow, single layer, densely packed with 2–4(5)-celled assimilatory filaments; storage tissue compact, sometimes with a few sclerotic cells and/or mucilage cavities, also with scattered oil cells each containing a single, large oil body, these present as well elsewhere in thallus and scales; numerous rhizoids ventrally, some smooth, others pegged, rarely with inner thickenings spirally connected. *Ventral scales* in 4 or more rows, covering part or all of ventral face and rarely projecting beyond margins, median scales bluntly triangular, constricted where joined to appendage, laminal scales smaller, sometimes in double rows, lacking an appendage, marginal scales rarely present. *Cupules* borne dorsally on thalli, hollowed, contracted below, flaring above, margin ciliate, lobed-ciliate, dentate or nearly entire, containing discoid gemmae that reproduce vegetatively.

Dioicous. *Gametangiophores* stalked. *Stalks* arising at apex of main and/or lateral branches, basally sometimes surrounded by large scales, generally without an appendage, along their length bearing filiform scales, 2–4 rhizoid furrows and 0–2 bands of air chambers with compound air pores. *Antheridiophores* with receptacular discs rather flat, lobed or divided into rays, antheridia and compound air pores on dorsal side, several rows of scales per lobe beneath. *Archegoniophores* with receptacles convex above, lobed or divided into $\pm$ flat rays, dorsally with compound air pores, below with scales and archegonia, each one surrounded by calyptra and pseudoperianth, in groups that are enclosed by bivalved involucre, occurring alternate with the lobes or rays (in African species). *Sporophytes* consisting of foot, short seta (elongating later) and subglobose capsule, its unistratose wall with annular thickenings, dehiscing irregularly. *Spores* small, thin-walled, $\pm$ triangular-globular, ornamentation with numerous thin, irregularly convoluted ridges or with few wide ridges separated by granules, the 2 faces similar or dissimilar. *Elaters* tapering at ends, bi- or trispiral. *Chromosome number*: $n = 9$ (basically).

On the basis of differences in spore morphology, germination patterns and flavonoid patterns, the genus is subdivided into 3 subgenera: *Marchantia*, *Chlamidium* and *Protomarchantia* R.M. Schust. The latter is absent from the region.

Key to local subgenera, sections and species

- 1a Thalli with margins plicate-crested, crenulate or lobulate, dorsally with or without dark median band; epidermal pores with walls of cells bordering inner opening slightly or strongly projecting and pores then cruciate; scales in 4–6 rows, covering $\frac{3}{4}$ or all of ventral surface and then also extending beyond thallus margins; appendages of median scales orbicular or reniform or ovate, marginal cells slightly or strikingly smaller than inner cells; laminal scales much wider than long; cupules with ciliate lobes at margins, externally with papillae; male receptacles peltate, shallowly dissected into 6–10 broad lobes; membranous margins of rays crenulate or entire and then with very small cells; female receptacles deeply dissected into 9–11 terete rays, with or without papillae; stalks with single broad band of air chambers; margins of involucre with ciliate lobes; spores 8–16 μm in diameter, ornamentation on 2 faces similar, with numerous narrow convoluted ridges subgenus *Marchantia* (p. 185);
- 2a Thalli with margins entire or crenulate, crested-plicate; dorsally often with dark median band; cells bordering inner opening of epidermal pores with slightly convex inner walls, pores not cruciate; ventral scales in 6 rows and extending beyond thallus margins; appendage of median scales small, margins bordered with somewhat smaller cells; membranous margin of male receptacle crenulate, composed of slightly smaller cells; rays of female receptacle with numerous papillae 1. *M. polymorpha*
- 2b Thalli with margins lobulate; dorsally without dark median band; cells bordering inner opening of epidermal pores with strongly convex inner walls and pores cruciate; ventral scales in 4(–6) rows and not extending beyond thallus margins, marginal scales sometimes partly or altogether absent; appendage of median scales large, margins entire or slightly crenulate, bordered with strikingly small marginal cells; membranous margin of male receptacle not distinctly crenulate, composed of very small cells; rays of female receptacle without papillae 2. *M. berteriana*
- 1b Thalli with margins entire, nearly flat or sometimes slightly undulate, dorsally with or without dark median band; cells bordering inner opening of epidermal pores with straight or convex walls, rarely with strongly projecting processes and then pores cruciate; scales in 4 rows, covering $\frac{1}{4}$ to almost $\frac{2}{3}$ of ventral surface; appendage of median scales orbicular, ovate or $\pm$ triangular, apically acuminate, acute or apiculate, marginal cells smaller than inner ones; laminal scales as long as or longer than wide; cupules with margins ciliate, almost entire or rarely with ciliate lobes, externally rarely with papillae; male receptacles palmate or rarely peltate, shallowly or deeply dissected into rays; membranous margin of lobes entire or slightly crenulate; female receptacles dissected into 5–9 apically $\pm$ flat lobes; margins of involucre ciliate or entire, rarely with ciliate lobes; stalks with air chambers in 1 or 2 bands; spores 20–35 μm in diameter, ornamentation on 2 faces dissimilar, distally mostly with wide ridges subgenus *Chlamidium* (p.192);
- 3a Thalli medium-sized to large, 6–8(11) mm wide; epidermal pores with inner walls of cells bordering inner opening strongly projecting and pores cruciate; appendages of median scales with margins entire or slightly denticulate; cupules with triangular, ciliate lobes and externally with numerous papillae; female receptacle deeply dissected into lobes, apically truncate or emarginate; margins of involucre with ciliate lobes section *Paleacea* (p. 192), 3. *M. paleacea*
- 3b Thalli smallish to large, 3.5–10.0 mm wide; epidermal pores with inner walls of cells bordering inner opening straight or convex; appendages of median scales with margins often distinctly toothed; cupules bearing long or short cilia or almost entire at margins and externally without or with few papillae; female receptacle shallowly or deeply dissected into lobes; margins of involucre ciliate or $\pm$ entire;

- 4a Thalli 6.0–8.5 (–10.0) mm wide; dorsally without dark median band; appendages of median scales large, 520–550 × 375–530 µm, inner cells also comparatively large, 75.0–87.5 × 32.5–42.5 µm, i.e. cell structure loose; margins of cupules with cilia up to 6 cells long; female receptacle large, shallowly dissected into broad lobes, sometimes bearing a male ray; margins of involucre ciliate section *Chlamidium* (p. 195), 4. *M. pappeana*
- 4b Thalli 3.0–7.5 mm wide; mostly with distinct dark median band dorsally; appendages of median scales small, 350–375 × 275–340 µm, inner cells not markedly 'loose', cells 67.5–75.0 × 30.0–37.5 µm; margins of cupules crenulate or with short cilia, up to 3 cells long; female receptacle rather small, deeply dissected into narrow lobes; margins of involucre entire or crenulate section *Papillatae* (p. 199), 5. *M. debilis*

Subgenus *Marchantia*

Marchantia L. sect. *Astromarchantia* Nees: 60, 61 (1838) (nom. illegit.)

Marchantia L. (without rank) *Stellatae* Gottsche, Lindenb. & Nees: 522 (1844–1847; published 1846)

Marchantia L. (without rank) *Marchantiotypus* Dumort.: 150 (1874).

Thallus branches wide, from nearly 7 mm to almost twice as wide; margins crenulate, lobulate or plicate-crested. *Dorsal epidermis* with or without papillae; air pores surrounded by 4–5(6) concentric rings of cells, at inner openings sometimes with rounded walls, otherwise with pronounced processes and pores then cruciate; storage tissue lacking sclerotic cells. *Scales* in 4–8 rows, covering $\frac{3}{4}$ to all of ventral face, containing scattered oil cells; median scales with appendages, ovate, orbicular or reniform, not acuminate at apex; margins crenulate, toothed or entire, sometimes with a row of cells very much smaller than those in interior; laminal scales wider than long, on either side of median scales, apically rounded, lacking papillae, upper cell walls with trigones. *Cupules* with acutely triangular, toothed lobes, externally papillate.

Dioicous. *Antheridiophores* with receptacles ± symmetrical, peltate, rays very short and broad; stalks with 2 rhizoid furrows, but lacking air chambers. *Archegoniophores* with receptacle deeply dissected into terete lobes; stalks with 2 rhizoid furrows and a single band of air chambers; involucre with toothed or ciliate margins. *Spores* small, 8–16 µm in diameter; 2 faces similarly ornamented, with numerous thin, highly convoluted ridges, triradial mark distinct to absent and wing absent.

Marchantia polymorpha, *M. berteriana* and *M. plicata* (from central and South America) are classified in subgenus *Marchantia*.

1. *Marchantia polymorpha* L. in Species plantarum edn 1: 1137 (1753); Bischl.: 34 (1993a). Type: Europe, *Dillenius* in Historia Muscorum, t. 76, fig. 6E, F (1742) [OXF, lecto., typo., fide Bischl. & Boisselier-Dubayle: 363 (1991) (photo. of typo. in PRE!)]

Synonymy after Bischler-Causse (1993a).

Thallus large, mostly prostrate, sometimes growing somewhat erect, apical segments broadly obovate, bright or dark or yellowish green, medianly with or without dark, continuous or interrupted band dorsally (Figure 1A), margins reddish brown, crisped, entire, sometimes crenulate; pores quite small to large, subdorsal air chamber walls visible from above; margins not raised and incurved when

dry; in crowded, overlying patches, repeatedly pseudodichotomously furcate. *Branches* with total length up to 35 mm, terminally 2–15 mm long and successive branches 5–10(–14) mm apart, narrowly divergent to overlapping, 7–10 mm wide, 325–375 µm thick over midrib, laterally thinning out into wings, apex notched, with appendages of several purple-red median scales recurved over edge; margins acute, thin, becoming recurved, flanks sloping obliquely, ventral face medianly keeled (Figure 1C), densely covered with rhizoids and on either side with 3 rows of purple or brownish scales, the outermost extending beyond thallus margins (Figure 1B).

Dorsal epidermal cells unistratose, mostly hyaline, 4–6-sided, 35–74 × 18–30 µm, thin-walled, lacking trigones, in transverse section 18–20 µm thick, marginal cells in 3(4) rows (Figure 1G), those in outer 1 or 2 rows smaller, generally rectangular, 15.0–27.5 × 17.5–20.0 µm, inner cells larger, 27.5–37.5 × 22.5–27.5 µm; air pores quite numerous, 175–350 µm distant from each other, raised, compound, round or oval, 30.0–62.5 × 40.0–60.0 µm, surrounded by 4 or 5 concentric rings of cells, 2 or 3 above epidermis and 2 or 3 projecting into air chambers (Figure 1F), innermost ring of upper cells collapsed, ± 5 µm wide, next ring of cells ± 40 × 10 µm, outer ring of cells ± 50 × 12 µm, partly overlying epidermal cells (Figure 1D), inner opening mostly surrounded by 4 cells (Figure 1E), ± 27.5 µm long, and ± 12.5 µm wide across widest parts which protrude into cavity and are covered with black granular deposit. *Assimilation tissue* 50–100 µm thick, $\frac{1}{6}$ – $\frac{1}{3}$ as thick as thallus, air chambers in a single layer, 150–250 µm wide, height of bounding walls 2 or 3(4) cells, round or oval, 17.5–27.5 × 15.0–17.5 µm, chambers internally crowded with densely chlorophyllose, mostly 2- or 3-celled filaments (Figure 1F), cells round, oval, elongated or irregular, 20.0–32.5 × 15.0 µm; storage tissue occupying ± 11 rows of cells in ventral $\frac{2}{3}$ – $\frac{5}{6}$ of thickness of thallus medianly, decreasing laterally, cells angular, 45.0–75.0 × 60.0–65.0 µm, smaller just below air cavities and where adjoining ventral epidermis; sclerotic cells and mucilage cavities absent; rhizoids some smooth, 15–50 µm wide, faintly brown, others tuberculate, 7.5–12.5 µm wide, and still others with internal 'spirals', ± 12.5 µm wide.

Median scales (Figure 1K) pale mauve, in one row on either side of midrib, ± obliquely triangular, body up to 750 µm long, width 1575–2250 µm across nearly straight base, continuing into narrow 'tail', cells in body of scale elongated, 4–6-sided, 85–160 × (25–)40–62 µm, rhizoids arising from a few smaller rhizoid initial cells and with 5 or 6 scattered oil cells present, ± 25.0 × 22.5 µm, toward margins cells changing orientation and some in semiradial groups, from centre of which 1 or 2 papillae project, 35–50 × 10 µm; scale narrowing upwards, deeply constricted where joined with appendage, which is broadly

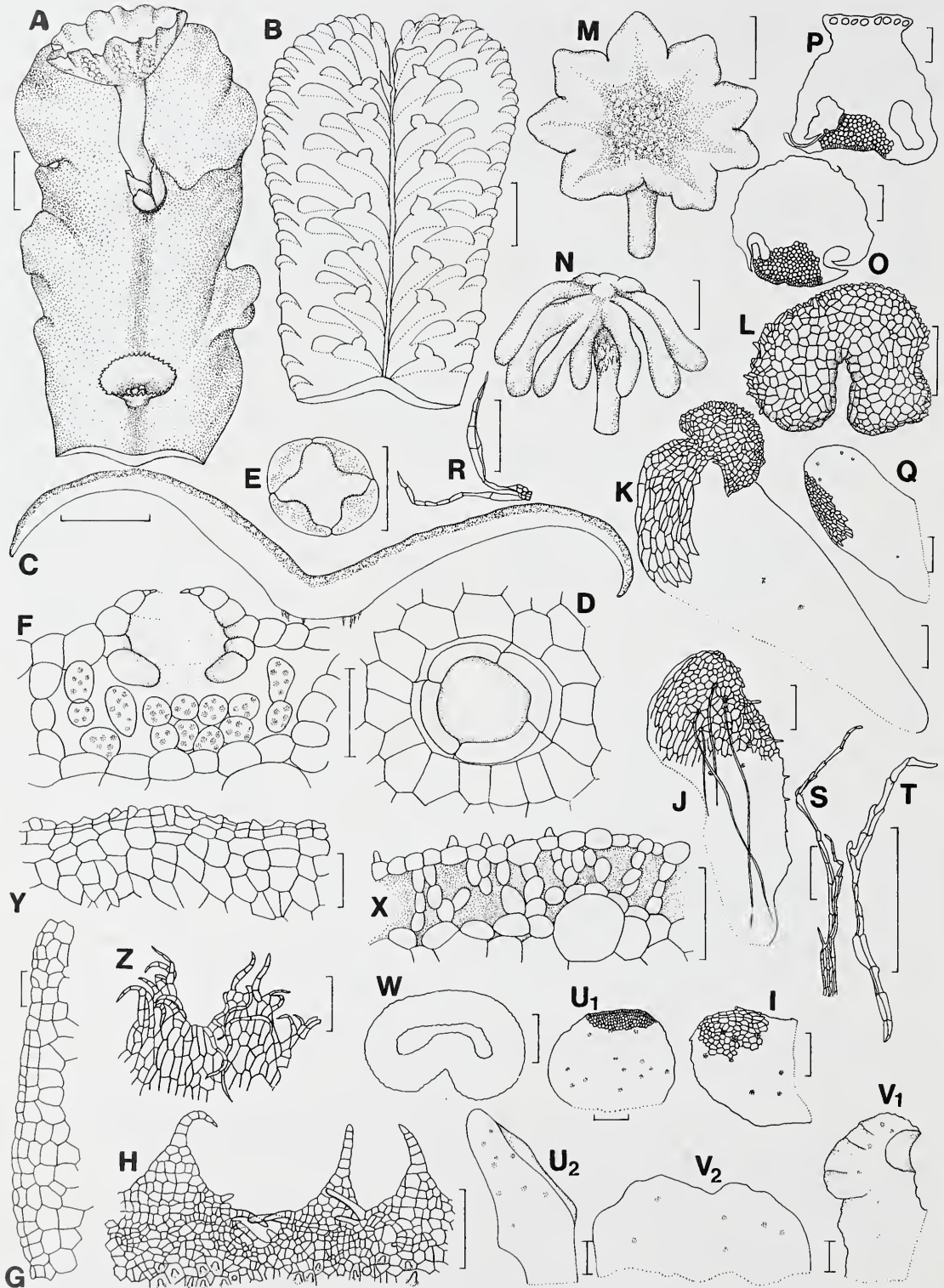


FIGURE 1.—*Marchantia polymorpha* L. subsp. *ruderalis*. A–G, thallus: A, dorsal face of apical branch of ♂ with disc and cupule; B, ventral face of apical branch; C, t.s. of branch; D, air pore and surrounding cells from above; E, air pore from below; F, t.s. of air pore, dorsal epidermal cells and air chamber; G, margin. H, cupule margin; I, marginal scale; J, laminal scale; K, median scale; L, appendage of median scale; M, ♂ receptacle; N, ♀ receptacle from side; O, t.s. of ♂ stalk; P, t.s. of ♀ stalk; Q, median scale of ♂ receptacle; R–V, scale; R, along ♂ stalk; S, ♀ receptacle; T, along ♀ stalk; U₁, U₂, foot of ♂ stalk; V₁, V₂, foot of ♀ stalk. W, t.s. of ♀ ray; X, detail of part of section of ♀ ray, showing papillae on epidermal cells and air chambers; Y, margin of ♂ ray; Z, margin of involucre. A, M, O, Q, R, U₁, U₂, Y, *Perold & Koekemoer* 3248; B–L, N, P, S, T, V₁, V₂, W₁, X, Z, *Glen* 3728. Scale bars: A, B, M, N, 2 mm; C, 1 mm; D–F, 50 µm; G, X, Y, 100 µm; H–L, O–W, 250 µm.

rounded, brown or tinged with purple, (350–) 400–640 × 500–700 µm, central cells 4–6-sided, 42.5–62.5 × 32.5–50.0 µm, with 1–3 oil cells, up to 30.0 × 22.5 µm, margin sharply toothed, crenulate or almost entire, cells small, some conical, ± 22.5 × 15.0 µm, projecting slightly, others rectangular, with long axis parallel to margins, ± 35.0 × 7.5 µm, or perpendicular, with 10 µm high protuberance, sometimes separated as distinct cell, submarginal cells larger, 25.0–27.5 × 20.0–37.5 µm. *Laminal scales* hyaline or pale mauve, in one row on either side of and lateral to median scales, almost wedge-shaped, but with apex rounded, base flatly arched (Figure 1J), 600–825 × 1450–1750 µm, upper cells rather irregularly arranged, some with slightly thickened walls, 4–6-sided, 37.5–42.5 × 17.5–27.5 µm, larger lower down, 70–90 × 30–35 µm, oil cells rare, 5 or 6 rhizoids originating from smaller internal initial cells, at upper margin, several papillae, ± 47.5 × 12.5 µm. *Marginal scales* (Figure 1I) usually projecting beyond thallus margins, hyaline or brownish, oblong or ovate, apex rounded, 700–750 × 550–650 µm, upper cells with walls thickened and brown, ± 47.5 × 32.5 µm, lower down walls not thickened, cells 70.0–120.0 × 25.0–37.5 µm, up to 5 or 6 scattered oil cells and some rhizoid initials present. *Cupules* with ciliate, ± triangular lobes (Figure 1H), ± 240 µm long and 250–275 µm wide at base, apically with 5 or 6 cells in a uniseriate, vertical row, top cell conical, ± 20 × 10 µm, lower cells gradually enlarging, bottom cell trapezoid, ± 27.5 × 32.5 µm, at base of lobes on either side 3 or 4 transversely projecting cellular filaments or cilia, 1–6 cells long, cells ± 35 × 10 µm, lower down cupule wall several cell layers thick, exteriorly with numerous 1–3-celled papillae and internally with many oil cells.

Dioicous. Antheridiophore arising from apex of terminal segment (Figure 1A) of main or short lateral branch, raised on stalk, ± 4.5–15.0 mm long, in transverse section rounded, at widest part along its length, ± 975 × 1000 µm (Figure 1O), cortical cells small, 10.0–17.5 × 7.5–20.0 µm, outer wall slightly thickened and bulging, medullary cells larger, angular, 22.5–45.0 × 22.5–35.0 µm, air chambers absent, but with 2 rhizoid furrows, 237.5–250.0 × 87.5–137.5 µm, lined with purple pigmented cells; *scales* at base of stalk (Figure 1U₁, U₂), large, with purple bases, round or oblong, lacking an appendage, 1250–2000 × 800 µm, cells in body of scale, 50.0–57.5 × 20.0–30.0 µm, smaller at apex and margin, 22.5–37.5 × 12.5 µm, sometimes with protruding papillae, up to 8 scattered oil cells present; *scales along length of stalk*, hyaline, filiform (Figure 1R) (1)2–3 cells wide; *receptacle* ± 8 mm in diameter, shallowly dissected into 8(–10) lobes, ± 375 µm long, symmetric (Figure 1M), basal sinus up to 30° wide; margins of lobes (Figure 1Y) membranous, hyaline, crenulate, cells in outer 1 or 2 rows small, 10.0–17.5 × 15.0–22.5 µm, some with a bulging protrusion, inner cells larger, 30.0–72.5 × 32.5–37.5 µm; *median scales* on ventral side of lobes (Figure 1Q) hyaline, oblong with rounded apex and lacking appendage, 1375–1575 × 600–850 µm, cells in body of scale 4–6-sided, 50.0–75.0 × 27.5–30.0 µm, 4–10 oil cells present, ± 25 × 25 µm, upper marginal cells thin-walled, small, 7.5–15.0 × 12.5–15.0 µm, sometimes toward base of lateral margins, with small papillae.

Archegoniophore arising from apex of terminal segment of main or short lateral branch, raised on stalk, 17–40 mm long, in transverse section 1000 × 1250 µm, narrower across

single band of air chambers, ± 625 µm (Figure 1P), cortical cells small, 10.0–20.0 × 7.5–17.5 µm, outer wall slightly thickened, medullary cells angular, 37.5–42.5 × 25.0–32.5 µm, with 2 rhizoid furrows, ± 350 × 250 µm; *scales at base of stalk*, (Figure 1V₁, V₂), large, purple or brown or hyaline, rarely with slightly constricted appendage, mostly without, but some appear to be composite scales, shape irregular, up to 750 × 1000(–1750) µm, inner cells ± 50 × 45 µm, small at crenulate upper margin, 17.5–25.0 × 12.5–27.5 µm, at lateral margins toward base, sometimes with papillae, ± 35 × 15 µm; *scales along length of stalk* (Figure 1T), hyaline or brown, filiform, up to 600 µm long, apical cell conical, ± 55.0 × 12.5 µm, lower 2(3) cells ± 62.5 × 20.0 µm, serially arranged and then 2 adjacent, sometimes with base of upper cell wedged between them, and sometimes with a short lateral branch; *receptacle* 9.5–10.0 mm in diameter, nearly symmetric, with small round projection dorsally, deeply divided into 9–11 rays of slightly unequal length (Figure 1N), 2500–3200 µm, basal sinus ± 40°, margins distally decurved and terete in transverse section (Figure 1W), toward apices with numerous conical papillae (Figure 1X), ± 12.5 × 17.5 µm; involucre with margins hyaline or occasionally purple-tinged, with tapering ciliate lobes (Figure 1Z), 300–350 µm long, 90–150 µm wide at base, inner cells 5- or 6-sided, 52.5–75.0 × 22.5–32.5 µm, with scattered, smaller oil cells in between, cilia (1)–2.5 cells or up to 230 µm long, top cell conical, 37.5–47.5 × 10.0 µm, basally with single cell, 72.5 × 25.0 µm, but sometimes with 2; *scales of receptacle* (Figure 1S) hyaline, up to 2000 µm long and 80 µm or 6 cells wide at base, apical cell conical, ± 62.5 × 12.5 µm, following 3 cells in a vertical row, ± 57.5 × 15 µm, basal cells 62.5–87.5 × 12.5–20.0 µm, sometimes branched along the length. *Spores* 10.0–12.5 µm in diameter, triangular-globular, yellow; distal face (Figure 2A, B) with numerous highly convoluted and branched, smooth ridges; proximal face (Figure 2C, D) with faint, collapsed triradiate mark, facets finely and densely granular, narrowly winged. *Elaters* yellow-brown, 350–435 × 5 µm, gradually tapering to narrow tips, bispiral. *Chromosome number*: n = 9 (Bischler-Cause 1993a).

Marchantia polymorpha, which has been known since classical times, is widespread. It has frequently been described but until recently its taxonomy has been unresolved because proper lectotypification had not been done. Arnell (1963) reported it in southern Africa from Golden Gate, near Clarens in the eastern [Orange] Free State and from Zimbabwe [Southern Rhodesia], near Odnazi River Bridge, Umtali. These specimens are not held at PRE or at BOL and up to now, the presence here of *M. polymorpha* under natural conditions has not been confirmed. Bischler-Cause (1993a) stressed the need for such confirmation. It is therefore considered worthy of note that female specimens of *M. polymorpha* with cupules have recently been collected at Johannesburg Botanical Garden, Glen 3468 & 3728, in a shade house and also at Sterlig Nursery, Krugersdorp, *Perold & Koekemoer CH 13640* (Figure 3). The plants are clearly introduced, but a description is nevertheless given. To complete the description and illustrations fresh male plants collected on a pavement in Ledbury, England, *Perold & Koekemoer 3248*, had to be used.

The specimens above have been referred to *M. polymorpha* subsp. *ruderalis* Bischl. & Boisselier-Dubayle,

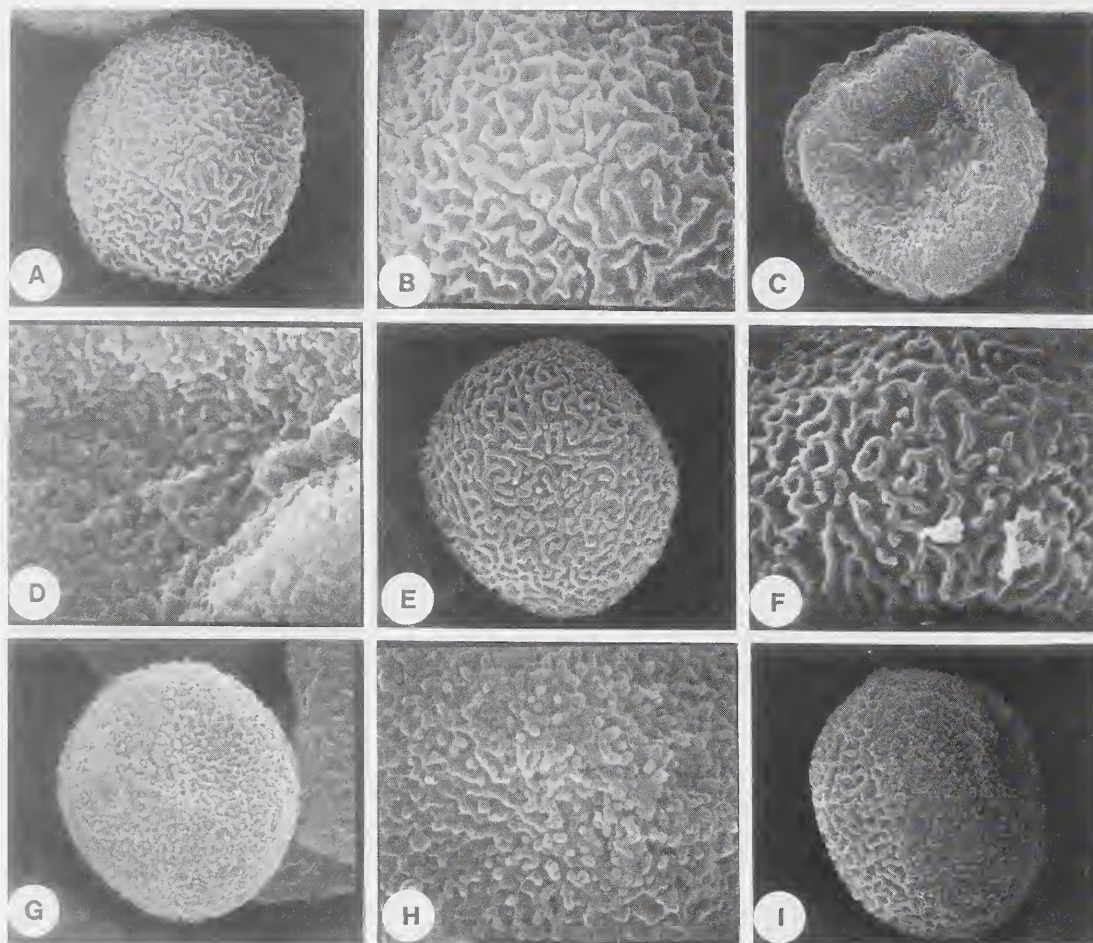


FIGURE 2.—SEM micrographs of spores. A–D, *Marchantia polymorpha*, S.M. Perold & M. Kockemoer 3248; A, distal face; B, part of distal face much enlarged; C, proximal face; D, part of proximal face much enlarged. E–I, *M. berteriana*, Geldenhuys 1332; E, distal face; F, part of distal face much enlarged; G, proximal face; H, part of proximal face much enlarged; I, side view. A, C, $\times 3006$; B, D, $\times 5780$; E, $\times 3044$; F, H, $\times 5596$; G, $\times 2875$; I, $\times 3006$.

since they grow as weeds in man-made habitats and agree in other respects with this subspecies, as distinguished by Bischler-Causse & Boisselier-Dubayle (1991). They are characterized by the fresh thalli being prostrate and bright green, with a dark, rather indistinct and discontinuous median band with elongated air chambers, by the dorsal air pores being $50.0\text{--}62.5\text{ }\mu\text{m}$ wide, the dorsal epidermal cells $35\text{--}55\text{ }\mu\text{m}$ long and the median scale appendages having toothed margins and being $350\text{--}500 \times 510\text{--}760\text{ }\mu\text{m}$ in size. The other 2 subspecies of *M. polymorpha*, *polymorpha* and *montivagans*, have so far not been found in southern Africa. They are distinguished by occurring in natural habitats, with the former growing more or less erect, being dark green, with a conspicuous median dark band lacking air chambers, having small air pores, short dorsal epidermal cells and the median scale appendages having entire margins; the latter subspecies is prostrate, yellow-green, lacks a median band, the air pores are larger, the dorsal cells are of intermediate length and the median scale appendages are of average size and the margins toothed. The distinguishing characters of the subspecies are given, in case *M. polymorpha* subsp. *polymorpha* and *M. polymorpha* subsp. *montivagans* are found in southern Africa in the future.

Lectotypification of *M. polymorpha* was recently done by Bischler-Causse & Boisselier-Dubayle (1991) by means of a Dillenian illustration and by a specimen held in OXF (i.e. a typotype). This corresponds to the first of three Linnean varieties (Linnaeus 1753), namely var. $[\infty]$, which was later called '*aquatica*'. This first variety $[\infty]$ forms the basis for the application of the specific name (Isoviita 1970). However, since the lectotype of *M. polymorpha* var. *polymorpha* of Linnaeus corresponds to the taxon '*aquatica*' (at any rank), it renders that name illegitimate, because the epithet '*polymorpha*' would be used for a taxon not including its type. The best procedure seemed, therefore, for Bischler-Causse & Boisselier-Dubayle to describe their three newly separated electrophoretic groups (in three enzyme systems: esterases, peroxidases and acid phosphatases) as subspecies, give two of them new names and select good, recent type specimens. *M. polymorpha* L. subsp. *polymorpha* thus corresponds to the taxon formerly called '*aquatica*'; *M. polymorpha* L. subsp. *ruderalis* Bischl. & Boisselier-Dubayle corresponds roughly to the former *polymorpha* '*sensu stricto*' and *M. polymorpha* L. subsp. *montivagans* Bischl. & Boisselier-Dubayle roughly to the former '*alpestris*'.

On chemical evidence Markham *et al.* (1977) had previously concluded that the three taxa of *M. polymorpha* should be treated as varieties rather than as separate species, since they all possess identical flavone glucuronides.

The time of going to press of Schuster's (1992) monumental work pre-dated the publication by Bischler-Causse & Boisselier-Dubayle (1991) on the lectotypification of *M. polymorpha*, but judging by some of the remarks contained in it, it is by no means certain that he would have accepted it. He still subscribes to the genetic analyses of Burgeff (1943), although they have been shown to be out of date, and he therefore treats the segregates of *M. polymorpha* as distinct species.

As mentioned above, in southern Africa *M. polymorpha* subsp. *ruderalis* is only known from man-made sites, i.e. in nurseries. Its presence in natural habitats has not been confirmed. Asakawa *et al.* (1988) refer to the distribution of sesquiterpenoids and cyclic bis-benzyls in southern African collections of *M. polymorpha*, but it is not known where the material was obtained from or who identified it. Magill & Schelpe (1979) and Arnold & De Wet (1993) list *M. polymorpha* as occurring in southern Africa, but these lists are based on erroneous information in the literature.

Marchantia polymorpha is very similar to *M. berteriana*, but can be distinguished from it by the marginal scales which are always present and which mostly extend beyond the crisped, sometimes crenulate thallus margins; by the air pores not being cruciate; by the presence of numerous papillae on the rays of the female receptacle and by the appendages of the median scales bordered by larger cells.

2. *Marchantia berteriana* Lehm. & Lindenb. in Lehm., *Novarum et minus cognitarum stirpium*, pugillus 6: 21 (1834); Gottsche *et al.*: 481 (1846); Steph.: 393 (1898–1900); Schiffn.: 41–44 (1896); A. Evans: 246 (1917); Hässel de Menéndez: 160 (1963); S.W. Amell: 55 (1963); E.O. Campb.: 122 (1965); Bischl.: 44 (1984); Bischl.: 81 (1989a); Bischl.: 56 (1993a). Type: 'In insula Juan Fernandez, legit cl. Bertero (Herb. Hooker)', (W8294, holo.; FH, G, NY, PC, STR, W, iso.).

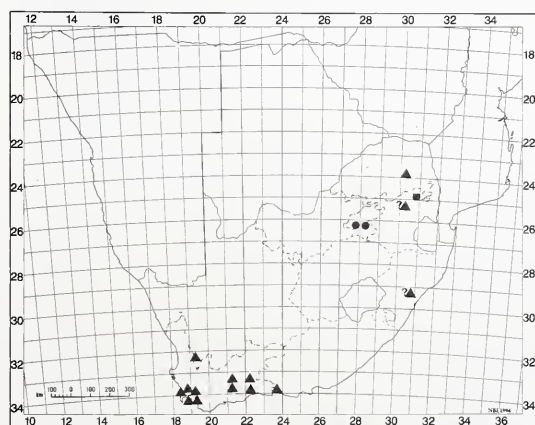


FIGURE 3.—Distribution of *M. polymorpha* var. *ruderalis*, ●; *M. berteriana*, ▲; and *M. paleacea*, ■, in southern Africa.

M. tabularis Nees: 71 (1838); Sim: 28 (1926). Type: South Africa, Tafelberg, leg. Ecklon (W8289) (female) W!, syn.; leg. Bergius (male) STR, syn.

M. contracta Bisch.: 135 (1846) (fide Bischler-Causse (1993a)). Type: South Africa, Cap. Duynsberg, Krauss s.n. (BM, FH, G!, PC, W).

For the rest of the synonymy consult Bischler-Causse (1993a).

Thallus robust, rather flat, almost leathery, apical segments broadly oblong (Figure 4A), green, yellowish green or bluish green and occasionally with some purple pigmentation, without distinct median band dorsally, margins hyaline, purplish or brownish, irregularly lobulate, more or less plicate but not crisped, entire or minutely crenulate, pores numerous, small, almost closed, subdorsal air chamber walls indistinct from above, when wet; thallus margins not raised or incurved, when dry; in crowded, overlying mats, repeatedly furcate but rather irregularly so. Branches with total length up to 80 mm, terminally up to 20 mm long and successive branches 6–10 mm apart, narrowly to moderately divergent, 9.5–12.0(–15.0) mm wide, 600–900 µm thick over midrib, laterally thinning out into wings (Figure 4C); apex notched with brownish, hyaline or partly purplish red appendages of median scales recurved over edge; margins acute, thin, slightly recurved, flanks sloping obliquely; ventral face (Figure 4B) brownish or purplish, medianly keeled, covered with rhizoids, and with 2 rows of scales on either side (sometimes with 3), extending over $\frac{3}{4}$ – $\frac{9}{10}$ of thallus width, but never right to the edge.

Dorsal epidermal cells unistratose, seldom bistratose in patches, hyaline, polygonal, 4–7-sided, (50–)57.5–77.5 × 20.0–30.0 µm, walls slightly thickened, in transverse section 15–20 µm thick, occasionally containing an oil body; along margins (Figure 4G) 3 or 4 rows of cells, smallest in the outermost row, rectangular or polygonal, 17.5–22.5 × 10.0–15.0 µm, enlarging inwardly, 27.5–37.5 × 25.0–37.5 µm, air pores numerous, (107.5–)137.5–185.0 (–225.0) µm distant from each other, raised, compound, oval (37.5–)57.5–75.0 × 27.5–47.5(–55.0) µm, encircled by (4)5–7 concentric rings of cells, 3(4) above epidermis and 3 or 4 projecting into air chambers (Figure 4F), innermost ring with collapsed cells ± 5 µm wide, uppermost ring with 4 or 5 sausage-shaped cells, 50–55 × 10 µm, also 4 or 5 cells in next ring, 45.0–47.5 × 27.5–32.5 µm, those in outermost ring irregular in shape as they adjoin or partly overlie dorsal epidermal cells (Figure 4D), 55.0–62.5 × 12.5–20.0 µm, inner opening with 4 or 5 cells, their inside walls covered with a granular deposit and strongly protuberant, leaving only a small, usually cruciate opening (Figure 4E₁, E₂). *Assimilation tissue* 45–50(–60) µm thick, $\frac{1}{10}$ – $\frac{1}{20}$ as thick as thallus, air chambers in a single layer, 77.5–120.0 µm wide, bounding walls 3 or 4 cells high, rounded or angular, 7.5–20.0 × 10.0–12.5 µm, chambers crowded with densely chlorophyllous filaments, cells oval, round or irregularly shaped, 15.0–20.0 × 12.5–15.0 µm; storage tissue occupying ventral $\frac{9}{10}$ – $\frac{19}{20}$ of thickness of thallus medianly, decreasing laterally, cells angular, up to 75 µm wide, becoming smaller lower down, containing scattered starch grains and some with an oil body, sclerotic cells and mucilage cavities absent; rhizoids some smooth, ± 27.5 µm wide, others pegged, 27.5–45.0 µm wide.

Median scales (Figure 4I) hyaline or purplish, in one row on either side of midrib, body ± obliquely triangular, up to 1450 µm long, across base 2875–3500 µm, hardly

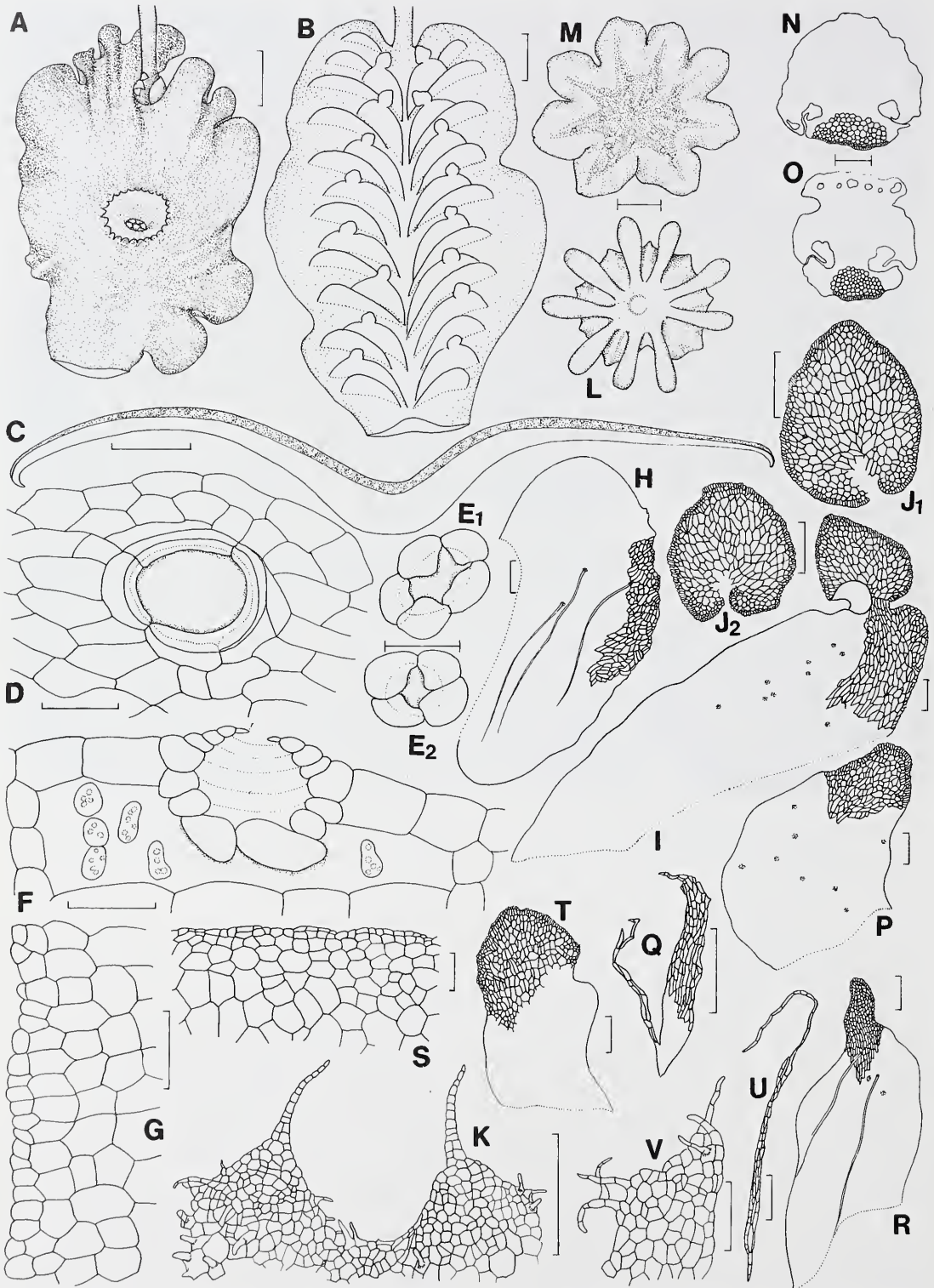


FIGURE 4.—*Marchantia berteriana* Lehm. & Lindenb. A–G, thallus: A, dorsal face of apical branch with cupule; B, ventral face of apical branch; C, l.s. of branch; D, air pore and surrounding cells from above; E₁, E₂, air pores from below; F, l.s. of air pore, dorsal epidermal cells and air chamber; G, margin. H, laminal scale; I, median scale; J₁, J₂, appendages of median scales; K, cupule margin; L, ♀ receptacle; M, ♂ receptacle; N, l.s. of ♂ stalk; O, l.s. of ♀ stalk. P–R, scale: P, from foot of ♂ stalk; Q, from along ♂ stalk; R, median scale of ♂ receptacle. S, margin of ♂ ray; T, scale from foot of ♀ stalk; U, scale from ♀ receptacle; V, margin of involucre. A, F, G, L, N, P, R, S, *A.E. van Wyk* 2066; B–E₁, E₂, H–J₁, J₂, M, O, T–V, *Geldenhuys* 1332; K, Q, *Pillans* 4048. Scale bars: A, B, L, M, 2 mm; C, 1 mm; D–G, 50 µm; H–K, N–R, T, 250 µm; S, U, 100 µm.

arched, central cells elongated and narrow, 4 or 5-(6)-sided, $125.0\text{--}212.5 \times 17.5\text{--}30.0 \mu\text{m}$, toward margins outer 7 or 8 rows of cells thinner-walled, orientation irregular and much smaller in size, $27.5\text{--}50.0 \times 20.0\text{--}22.5 \mu\text{m}$, with as many as 30 scattered oil cells, $\pm 87.5 \times 37.5 \mu\text{m}$, dark brown, scale gradually narrowing upwards and then $\pm 1875 \mu\text{m}$ wide, abruptly and deeply constricted at join with appendage, hyaline or purplish or both, orbicular to broadly ovate (Figure 4J₁, J₂), apex rounded to somewhat obtusely narrowed, basally cordate, $675\text{--}950 \times 650\text{--}800 \mu\text{m}$, median cells 4-6-sided, $80.0\text{--}95.0 \times 45.0\text{--}52.5 \mu\text{m}$, with 4 or 5 oil cells, margins entire or minutely crenulate, bordered by 1 or 2(3) rows of very small cells, $30.0\text{--}40.0 \times 10.0\text{--}20.0 \mu\text{m}$, mostly narrowly rectangular to subquadrate and orientated with long axis perpendicular to margin, sometimes alternating with 2 stacked cells parallel to margin, and even smaller, $12.5 \times 12.5\text{--}17.5 \mu\text{m}$. *Laminal scales* mostly hyaline, yellowish brown or reddish, lateral to, but also alternating irregularly with median scales, broadly rounded, lacking apical appendage, base flatly arched (Figure 4H), $850\text{--}1125 \times 1875\text{--}3375 \mu\text{m}$, cells in body of scale 4-6-sided, walls straight or sinuous, $92.5\text{--}125.0 \times 22.5\text{--}32.5 \mu\text{m}$, sometimes in upper part with thickened walls, but in 6 or 7 rows toward inner margins thinner-walled, smaller, $32.5\text{--}50.0 \times 12.5\text{--}25.0 \mu\text{m}$, and very variable in orientation, with ± 12 oil cells, margins entire or slightly crenulate. *Marginal scales* rarely to sometimes present, when more or less scattered and never extending beyond thallus margins, hyaline, crescent-shaped with rounded apex, $675\text{--}1250 \times 775 \mu\text{m}$, upper cells small, with thickened corners, $15.0\text{--}25.0 \times 12.5 \mu\text{m}$, inner cells with slightly sinuous walls, $35.0\text{--}58.5 \times 15.0\text{--}25.0 \mu\text{m}$, toward base cells 5- or 6-sided, up to $112.5 \times 22.5 \mu\text{m}$. *Cupule* margins with ciliate, $\pm$ triangular lobes (Figure 4K), up to $675 \mu\text{m}$ long and $250 \mu\text{m}$ wide at base, at apex with 10 or 11 cells in a tapering, uniseriate, vertical row, top cell conical, $\pm 32.5 \times 7.5 \mu\text{m}$, lower cells larger, up to $37.5 \times 30.0 \mu\text{m}$, at base of lobes on either side a few transversely projecting (2-)3 or 4(-6)-celled cilia, lower down cupule wall several cell layers thick, exteriorly with numerous 1- or 2(-3)-celled papillae, $32.5\text{--}50.0 \times 20.0 \mu\text{m}$ and internally with many oil cells.

Dioicous. *Antheridiophore* arising from apex of terminal segment of main or short lateral branch, raised on stalk (Figure 4N), $23\text{--}30 \text{ mm}$ long, in transverse section rounded, diameter $\pm 1000 \mu\text{m}$, cortical cells small, $10.0\text{--}15.0 \times 12.5\text{--}17.5 \mu\text{m}$, with thickened outer wall, medullary cells larger, mostly angular, $22.5\text{--}45.0 \times 15.0\text{--}45.0 \mu\text{m}$, band of air chambers absent but with 2 rhizoid furrows, $\pm 162.5 \times 100.0\text{--}125.0 \mu\text{m}$; *scales at base of stalk* large (Figure 4P), hyaline or purplish, roughly triangular or oblong, sometimes slightly bulging, lacking an appendage, up to $1200 \times 1400 \mu\text{m}$, cells in body of scale 4-6-sided, often with sinuous walls, $47.5\text{--}87.5 \times 22.4\text{--}25.0 \mu\text{m}$, along upper margins 1 or 2 rows of much smaller cells, $12.5\text{--}25.0 \times 12.5\text{--}30.0 \mu\text{m}$, with up to 10 scattered oil cells throughout; *scales along length of stalk* (Figure 4Q) hyaline, filiform, sometimes only 3 cells wide but sometimes wider and up to 9 cells wide; *receptacle* (Figure 4M) up to 10 mm in diameter, shallowly dissected into $8(9) \pm$ symmetric lobes, basal sinus $\pm 80^\circ$ wide; margins of lobes membranous, brownish or hyaline, minutely crenulate, with 1 or 2 rows of small cells (Figure 4S), mostly rectangular across, $15.0\text{--}20.0 \times 10.0\text{--}22.5 \mu\text{m}$, in-

ner cells larger, $52.5\text{--}87.5 \times 37.5\text{--}40.0 \mu\text{m}$; *median scales* on ventral side of lobes (Figure 4R) hyaline, $750\text{--}1375 \times 1000\text{--}1875 \mu\text{m}$, cells in body of scale 4-6-sided, up to $125 \times 50 \mu\text{m}$, thin-walled, at margins smaller, $\pm 30.0 \times 17.5 \mu\text{m}$, appendage absent or present, $\pm 267.5 \times 200.0 \mu\text{m}$, oblong, rounded apically, not or hardly constricted at join with scale, inner cells $40.0\text{--}42.5 \times 15.0\text{--}22.5 \mu\text{m}$, smaller at margins.

Archegoniophore arising from apex of terminal segment of main or short lateral branch; raised on stalk $48\text{--}65 \text{ mm}$ long, in transverse section (Figure 4O) $1000 \times 925 \mu\text{m}$, constricted on inner side of single band of air chambers, cortical cells small, $12.5\text{--}20.0 \times 12.5\text{--}25.0 \mu\text{m}$, outer wall thicker, medullary cells angular, up to $60 \times 45 \mu\text{m}$, in between and at centre of stalk with smaller cells $\pm 25 \times 20 \mu\text{m}$, containing 2 rhizoid furrows, $\pm 240 \times 105 \mu\text{m}$; *scales at base of stalk* (Figure 4T), brownish or hyaline, without appendage, oblong or ovate, with apex rounded, large, $1575\text{--}2000 \times 800\text{--}1250 \mu\text{m}$, inner cells 4-6-sided, walls mostly straight, sometimes sinuous, $75.0\text{--}125.0 \times 27.5\text{--}42.5 \mu\text{m}$, margins apically occasionally slightly crenulate, with rectangular cells arranged at right angles to margin, small, $10.0\text{--}25.0 \times 12.5\text{--}25.0 \mu\text{m}$; *scales along length of stalk* (Figure 4U) hyaline, filiform, up to $6500 \mu\text{m}$ long, 2 or 3(4) cells wide, their average size $\pm 112.5 \times 25.0 \mu\text{m}$; *receptacle* (Figure 4L) up to 10 mm in diameter, nearly symmetric, dorsally with small round median projection, deeply divided into 9 linear rays, up to $2625 \times 550 \mu\text{m}$, basal sinus $\pm 45^\circ$ wide, margins distally slightly decurved and terete in transverse section, lacking papillae toward apex; involucre with margins hyaline or purplish, with tapering ciliate lobes (Figure 4V), base $100.0\text{--}175.0 \times 125.0\text{--}182.5 \mu\text{m}$, inner cells 5- or 6-sided, $35.0\text{--}37.5 \times 22.5\text{--}25.0 \mu\text{m}$, lower down with numerous oil bodies, up to $60.0 \times 37.5 \mu\text{m}$, each one almost filling a cell, lobes apically and at sides with numerous, tapering, branched and intertwined cilia, length up to $220 \mu\text{m}$ or 7 cells in series, $22.5\text{--}50.0 \times 20.0 \mu\text{m}$, with granules on walls of apical cells; *scales of receptacle* (Figure 4U) hyaline, filiform, up to $2150 \mu\text{m}$ long and $35.0\text{--}87.5 \mu\text{m}$ or 2-5 cells wide at base, often splitting further along and strands mostly only 2 cells wide, $80.0\text{--}87.5 \times 20.0\text{--}22.5 \mu\text{m}$, apical cell $\pm 75.0 \times 17.5 \mu\text{m}$. *Spores* $7.5\text{--}12.5 \mu\text{m}$ in diameter, $\pm$ globular, brownish, distal face (Figure 2E, F, I) with numerous, much convoluted and branched ridges; proximal face (Figure 2G, H, I) with faint triradiate mark and winged, densely covered with numerous fine granules and tiny irregular ridges. *Elaters* yellow-brown, $(550\text{--})600\text{--}640(770) \times 5 \mu\text{m}$, gradually tapering at both ends for $150\text{--}200 \mu\text{m}$, bispiral. *Chromosome number*: $n = 9$ (Bischler-Causse 1993a).

Marchantia tabularis was described from specimens collected on Table Mountain and was placed in synonymy under *M. berteriana* by Schiffner (1896). Although Stephani (1898-1900) accepted Schiffner's decision, he still applied the epithet '*tabularis*' and was followed in this by Sim (1926). Arnell (1963) gives only brief notes on *M. berteriana*. Bischler-Causse (1993a) recognized that *M. contracta*, collected by Krauss at Devil's Peak, also belongs here. *M. berteriana* is quite variable in size, but generally the plants are large. Sometimes six rows of ventral scales are present and some authors, e.g. Hässel de Menéndez (1963) and Engel (1990) recognize these as

belonging to a separate variety, namely var. *polylepida*. However, several authors (Campbell 1965; Bischler 1984) have pointed out that the number of rows of scales is too unstable to warrant the designation of a variety. Schuster (1992) has assigned *M. berteroaana* to his new monotypic section, *Berteroanae*, on the absence of marginal scales, on the cruciate inner openings of the epidermal pores with six rings of cells and on the tiny marginal cells of the median scale appendages. Bischler-Causse (1993c) is, however, not convinced that this splitting is necessary, since marginal scales are fairly frequently present and the pores are often similar to those in other species of subgenus *Marchantia*.

Marchantia berteroaana generally grows on damp soil, and sometimes on wet rocks, at stream banks, near waterfalls, along paths, in kloofs, passes, ravines, gorges, in forests under trees or in burnt-over areas.

It is widely distributed in the southern hemisphere, from South America, south to the Antarctic Peninsula and north to Costa Rica, islands of the Atlantic and south Indian Ocean, southern Africa, Australia, Tasmania, New Zealand, New Guinea, New Caledonia, Java and Sulawesi (Bischler-Causse 1993a). In southern Africa (Figure 3) it is known from the Western Cape, which has winter rain, and from Kwazulu-Natal as well as the Northern Province [Northern Transvaal] which have summer rain. Exact localities of two of these collections by Wilms and by MacLea are not known. This distribution indicates that the species seems to be indifferent to the seasonality of the rainfall, in contrast to several other members of the Marchantiales which are $\pm$ restricted to either winter or summer rainfall areas.

Of the 50 specimens examined 36% had cupules, 34% had antheridiophores and 46% archegoniophores; only 6% had both.

Specimens of *M. berteroaana* are easily distinguished by the tiny marginal cells of the median scale appendages, by the cruciate dorsal pores and by the lobulate thallus margins. The membranous margins of the rays of the male receptacle also have very small cells. Otherwise it is quite similar to *M. polymorpha*, except for the latter having papillae on the rays of the carpocephalum. The ornamentation of their spores is also quite similar.

Subgenus ***Chlamidium*** (Corda) Bischl., *Cryptogamic, Bryologie et Lichénologie* 3: 362 (1982); Bischl.: 89 (1989a); Bischl.: 65 (1993a).

Marchantia L. sect. *Chlamidium* (Corda) Nees: 60, 101 (1838). Type: *Chlamidium indicum* Corda (Sieber flora mart. exsicc. No. 375) = *Marchantia chenopoda* L. Type: Sieber 378 p.p. (W, neo.; STR, iso., fide Bischl. 1984).

Thallus branches rather narrow, from 2.4 to $\pm$ 10.0 mm wide, rarely more, margins nearly flat, entire, sometimes slightly undulate, rarely crisped. *Dorsal epidermis* without papillae; air pores surrounded by (4)–5–7 concentric rings of cells, at inner openings with straight or convex walls, rarely with pronounced, rounded processes, and pores then cruciate; storage tissue often with scattered

sclerotic cells. *Scales* in 4 rows, covering $\frac{1}{4}$ to $\frac{2}{3}$ of ventral face, with oil cells present or absent, median scales with appendages variously shaped, orbicular, ovate or triangular, apically often acuminate, acute or apiculate, seldom rounded; margins entire, crenulate-serrate, coarsely toothed or lobed; laminal scales as long as, or longer than wide, sometimes in 2 incomplete rows on either side of median scales, apically acute or obtuse, with papillae, upper cell walls lacking trigones. *Cupules* with margins ciliate, almost entire, or with ciliate lobes, externally without, or rarely with papillae.

Dioicous. *Antheridiophores* with receptacle symmetric or asymmetric, palmate or rarely peltate, rays shallowly or deeply dissected; stalks with 2(–4) rhizoid furrows, air chambers in a single band or absent. *Archegoniophores* with receptacle symmetric, or sometimes asymmetric; dissected into 5–9 rays, flat or convex but never terete; scales of receptacle in African species apically with marginal cells rectangular and long axis parallel to margins; involucre margins ciliate or crenulate to entire, rarely with ciliate lobes; stalks with 2–4 rhizoid furrows, air chambers in 1 or 2 bands. *Spores* larger than in subgenus *Marchantia*, 20–35 μ m in diameter; ornamentation on distal face generally with thick ridges separated by dense granules; on proximal face with coarse granules only, triradiate mark and thick wing usually present.

Subgenus *Chlamidium* contains three sections, *Paleaceae*, *Chlamidium* and *Papillatae*. Section *Paleaceae* contains a single species. Sections *Chlamidium* and *Papillatae* are each represented in southern Africa by a single species.

Marchantia section ***Paleaceae*** Bischl. in *Bryophytum Bibliotheca* 38: 90 (1989a); Bischl.: 67 (1993a). Type species: *M. paleacea* Bertol. [lecto. fide Grolle: 210 (1976)].

Thallus with branches (3.5–)6.0–8.0(–11.0) mm wide, irregularly spaced, narrowly divergent. *Dorsal epidermis* without papillae; air pores with inner opening cruciate, inside walls of bordering cells strongly protuberant. *Median scales* with appendage oblong, ovate or suborbicular, apically rounded, acute or shortly apiculate, basally cordate, width across broadest part 650–750 μ m, margins entire, crenulate or slightly denticulate; with 1, 2 or more oil cells. *Cupules* with margins triangularly lobed and ciliate, externally with 1- or 2-celled papillae.

Dioicous. *Antheridiophore* on stalk lacking band of air chambers and basally surrounded by large scales without an appendage; receptacle peltate, shallowly dissected into 6–10 broad, rounded lobes, dorsal surface without papillae. *Archegoniophore* on stalk having a single band of small air chambers, basally surrounded by large scales, their apices rounded, rarely with a short appendage; receptacle bearing prominent median projection dorsally, deeply divided into 8 or more convex lobes, basally costate, apically truncate or hardly broadened, emarginate; involucre margin with ciliate lobes. *Spores* 19–24 μ m in diameter, ornamentation on distal face lacking areolae, mostly covered with a rather featureless, granular layer or with very irregular ridges, broken up or folded in or convoluted; proximal face different, thickly winged, triradiate

mark faint, covered with dense granules or centrally with narrow, irregular granular ridges. Only *M. paleacea* belongs to this section. The ornamentation of its spores is distinctive. It also differs from the other two sections in subgenus *Chlamidium*, by the shape of the female receptacle and by the ciliate, lobed margins of the involucre and the cupules.

3. *Marchantia paleacea* Bertol., *Opuscoli scientifici di Bologna* 1: 242 (1817); Bischl.: 55 (1984); Bischl.: 91 (1989a); Bischl.: 68 (1993a) subsp. ***paleacea***. Type: Italy, Borgonuovo secus valles in Liguria orientali, *D. Turio*, 1810 [BOLO, lecto. fide Grolle (1976)].

M. papillata Raddi var. *italica* Raddi; 20 (1822). Syntypes: Italy, Contorni di Firenze, *Raddi s.n.* (BOLO, FH, FI, G, PC, STR).

For the rest of the synonymy see Bischler-Causse (1993a).

Thallus medium-sized to large, firm and occasionally somewhat leathery, apical segments oblong (Figure 5A), bright green to slightly bluish green, sometimes blotched with dark red pigmentation, generally lacking but now and then with faint, short stretches of dark median band dorsally, margins mostly deep red or pink, entire, proximally, however, undulate and scalloped, pores numerous, small, generally closed, subdorsal air chamber walls visible from above and these flecked with numerous white oil bodies, when wet; thallus margins $\pm$ crinkled, not raised or incurved, when dry; in crowded, overlying mats, repeatedly furcate. *Branches* with total length up to 45 mm, terminally up to 15 mm long and successive branches rarely more than 10 mm, but mostly less apart, narrowly divergent, (3.5–)6.0–8.0(–11.0) mm wide, 750–800 μ m thick over midrib, laterally thinning out into wings (Figure 5C), apex notched with dark red to marginally orange appendages of median scales recurved over edge; margins acute, thin, flanks sloping obliquely; ventral face (Figure 5B) dark red entirely or only medianly, and the remainder green, with 2 rows of scales on either side of ventral keel, extending over $1/3$ – $1/2$ of thallus width.

Dorsal epidermal cells mostly unistratose, here and there bistratose, hyaline, long-rectangular or polygonal, (45.0–)60.0–80.0 $\times$ 27.5–37.5 μ m, walls thin or slightly thickened, in transverse section 20.0–27.5 μ m thick, oil bodies usually subdermal, almost filling cell, $\pm$ 32.5 $\times$ 30.0–40.0 μ m, dark brown, globular to subglobular; along margins (Figure 5G) mostly with 3 rows of cells, narrowest in outermost row, long rectangular, 17.5–37.5 $\times$ $\pm$ 5.0 μ m, in next row 4- to 6-sided, 30.0–35.0 $\times$ $\pm$ 12.5 μ m, and in innermost row 30.0–52.5 $\times$ 17.5–27.5 μ m; air pores numerous, 192.5–262.5 μ m distant from each other, raised, compound, oval, 40.0–50.0 $\times$ 35.0–42.5 μ m, encircled by 4–(6–) concentric rings of cells, 2 or 3 above epidermis and up to 4 projecting into air chambers (Figure 5F), innermost ring with collapsed cells, $\pm$ 5 μ m wide, uppermost ring with (3)4 or 5 cells, 37.5–62.5 $\times$ 7.5 μ m, cells in next ring 37.5–42.5 $\times$ 7.5–12.5 μ m and in outer ring, sometimes up to six, 42.5–62.5 $\times$ 15.0–22.5 μ m (Figure 5D), inner opening with 4 or 5 cells, inside walls mostly with granular deposit and strongly protuberant, leaving only a small cruciate opening (Figure 5E₁, E₂). *Assimilation tissue* 75.0–100.0 μ m thick, $1/10$ – $1/8$ as thick as thallus, air chambers in a single layer, 112.5–187.5 μ m wide, bounding walls 3 or 4(5) cells high, 22.5–35.0 $\times$

20.0–27.5 μ m, crowded with chlorophyllose filaments, cells mostly irregularly shaped, 17.5–27.5 $\times$ 12.5–20.0 μ m; storage tissue occupying ventral $7/8$ – $9/10$ of thickness of thallus medianly, decreasing laterally, cells angular, crowded together, 52.5–67.5 μ m wide, walls pitted, central area sometimes stained purple, sclerotic cells and mucilage cavities absent in specimens seen, but reportedly sometimes present; rhizoids mostly smooth, 17.5–27.5 μ m wide, occasionally pegged, 10.0–17.5 μ m wide.

Median scales (Figure 5I) mauve, in one row on either side of midrib, body $\pm$ obliquely triangular, up to 1050 μ m long, base arched and continuing into long 'tail', when up to 3250 μ m wide, inner cells elongated, 4–6-sided, 52.5–87.5 $\times$ 20.0–25.0 μ m, walls straight or somewhat sinuous toward margin, cells in outer 8 or 9 rows with thinner, often sinuous walls, orientation very irregular and smaller in size, 15.0–55.0 $\times$ 12.5–20.0 μ m, sometimes 3 or 4 marginal cells grouped together and slightly raised in a little peak from centre of which 1 or 2 slender papillae project, scattered throughout up to 25 oil cells, $\pm$ 37.5 $\times$ 27.5 μ m, oil body almost filling cell, scale gradually narrowing upwards and then $\pm$ 750 μ m wide, abruptly deeply constricted at join with appendage (Figure 5J₁, J₂), marginally orange-brown or purplish, internally pink or occasionally hyaline, ovate, oblong or suborbicular, apically rounded, acute or shortly apiculate, basally cordate, rarely with small basal lobe, 810–875 $\times$ 650–750 μ m, inner cells 5- or 6-sided, 65.0–77.5 $\times$ 37.5–52.5 μ m, with 1, 2 or more oil cells or even none; margins entire, crenulate or slightly denticulate, bordered by 1 row of smaller cells, quadrate to rectangular, sometimes walls sinuose, 17.5–37.5 $\times$ 10.0–27.5 μ m, orientated parallel to or perpendicular or oblique to margin, sometimes partly protruding, submarginal cells $\pm$ 62.5 $\times$ 27.5 μ m. *Laminal scales* (Figure 5H₁, H₂) mauve or internally mauve and externally hyaline, in one row on either side of and lateral to, but alternating irregularly with median scales, $\pm$ oblong, but not quite symmetric, base slightly arched or oblique, 750–1575 $\times$ 500–650 μ m, cells in body of scale elongated, 4–6-sided, walls straight or sinuose, 55.0–100.0 $\times$ 17.5–27.5 μ m, with up to 10 scattered oil cells, toward margins cells smaller, 17.5–32.5 $\times$ 15.0–25.0 μ m, their orientation very variable, a few along inner sloping margin grouped together and forming individual little peaks from tips of which slender papillae project. *Cupule* margins (Figure 5K) with ciliate, $\pm$ triangular lobes, 380–420 μ m long and 200–240 μ m wide at base, apically up to 6 cells in a tapering, uniseriate, vertical row, top cell conical, 25.0–32.5 $\times$ 15.0–20.0 μ m, lower cells, 20.0–40.0 $\times$ 20.0–25.0 μ m, base of lobes broadened to 6–9 adjacent cells, 4- or 5-sided, 27.5–35.0 $\times$ 22.5–27.5 μ m, from margins of lobes on both sides, horizontally projecting, 1–3(4)-celled cilia, lower down cupule wall several cell layers thick, exteriorly with 1- or 2-celled papillae, up to 37.5 μ m long, and internally with numerous oil cells.

Dioicous. *Antheridiophore* not seen as none available for study. *Archegoniophore* arising from apex of terminal segment of main or short lateral branches, raised on stalk, 10–11 mm long, partly reddish, in transverse section (Figure 5N), 750 $\times$ 700 μ m, cortical cells small, 15.0–25.0 $\times$ 12.5–27.5 μ m, outer wall thicker, medullary cells rounded, 42.5–45.0 $\times$ 35.0–42.5 μ m, smaller cells in between and at centre of stalk, 12.5–22.5 $\times$ 20.0–25.0 μ m, with single

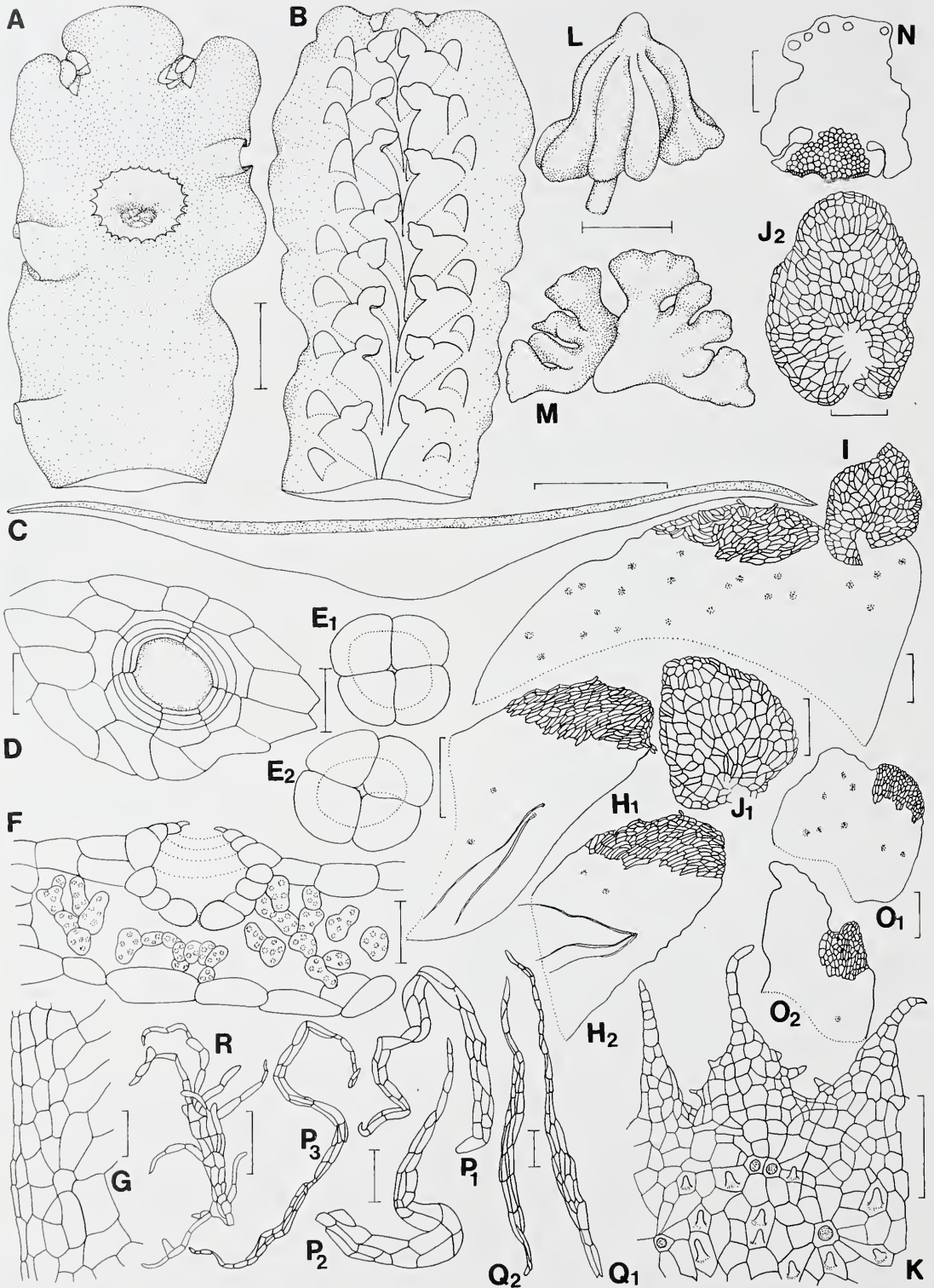


FIGURE 5.—*Marchantia paleacea* Bertol. A–G, thallus: A, dorsal face of apical branch; B, ventral face of apical branch; C, t.s. of branch; D, air pore and surrounding cells from above; E₁, E₂, air pores from below; F, t.s. of air pore, dorsal epidermal cells and air chamber; G, margin. H₁, H₂, laminal scales; I, median scale; J₁, J₂, appendages of median scales; K, cupule margin; L, ♀ receptacle from side; M, ♀ receptacle from above; N, t.s. of ♀ stalk. O–Q, scale: O₁, O₂, from foot of ♀ stalk; P₁–P₃, from along ♀ stalk; Q₁, Q₂, from ♀ receptacle. R, margin of involucre. A, E₁, E₂, G, I, J₁, J₂, Rankin 206; B–D, F, H₁, H₂, K, S.M. Perold 3264; L–R, C. Tavares LISU P 66716. Scale bars: A, B, L, M, 2 mm; C, 1 mm; D–G, 50 µm; H–K, N–R, 250 µm.

band of 4 small air chambers, $\pm 62.5 \times 30.0 \mu\text{m}$, and 2 rhizoid furrows, lined with purple-walled cells, $\pm 112.5 \times 72.5 \mu\text{m}$, *scales at base of stalk* (Figure 5O₁, O₂) conspicuous, brown, rounded or partly 2-lobed or irregularly shaped, often bulging, without or with short apical appendage, $1025\text{--}1150 \times 900\text{--}1750 \mu\text{m}$, inner cells 5- or 6-sided, $52.5\text{--}70.0 \times 25.0\text{--}32.5 \mu\text{m}$, with up to ± 10 oil cells, $30 \times 20 \mu\text{m}$, margins $\pm$ entire, cells quadrate or rectangular or irregularly shaped, $22.5\text{--}47.5 \times 15.0\text{--}20.0 \mu\text{m}$, long axis orientated parallel or perpendicular to margins; *scales along length of stalk* (Figure 5P₁–P₃) hyaline or purplish, filiform, up to $1750 \mu\text{m}$ long, toward apex ± 4 single cells in a row, $67.5\text{--}75.0 \times 10.0\text{--}20.0 \mu\text{m}$, lower down 3 or 4 cells wide, $75.0\text{--}132.5 \times 20.0\text{--}22.5 \mu\text{m}$; *receptacle* (Figure 5L, M) ± 4 mm in diameter, nearly symmetric, dorsally with prominent median projection, deeply divided into 8 lobes, up to $750 \mu\text{m}$ long, narrow at base and some of them wider at $\pm$ truncate apex, basal sinus $\pm 100^\circ$ wide; involucre with margins (Figure 5R) hyaline or purplish, divided into narrow lobes $\pm 500 \times 90 \mu\text{m}$, fringed with cilia $180\text{--}650 \mu\text{m}$ long, which consist of several cells in a uniseriate row, apical cell $\pm 75 \times 25 \mu\text{m}$, lower cells $82.5\text{--}92.5 \times 20.0\text{--}30.0 \mu\text{m}$, toward base often with 1 or 2 serially arranged transverse cells on one or both sides, originating at join between 2 successive cells; *scales of receptacle* (Figure 5Q₁, Q₂) hyaline or purplish, filiform, up to $2075 \mu\text{m}$ long, apically cells in a uniseriate row, $62.5\text{--}85.0 \times 12.5\text{--}22.5 \mu\text{m}$, then 2 cells and eventually 4 cells wide, up to $92.5 \times 25.0 \mu\text{m}$. *Spores* and *elaters* not available for study. *Chromosome number*: $n = 9$ (Bischler 1984, 1988, 1989a).

Marchantia paleacea has been known since the time of Micheli (1729), who described and illustrated it; but it was not accepted by Linnaeus (1753). After *M. polymorpha*, it was to become only the second species in the genus to be recognized from Europe, and was described by Bertolini (1817) from material collected in Italy.

It has been placed in subgenus *Chlamidium* on account of the four rows of ventral scales which are restricted to the median part of the thallus. It is assigned to the monotypic section *Paleaceae* because of the shape of the female receptacle, the structure of the margins of the involucre and the cupules, which have ciliate lobes (Bischler-Causse 1993a) with papillae externally.

The species has a circumtethyan distribution, ranging from the southern states of the USA, Mexico and Central America, to the Mediterranean, the Caucasus, the Himalayas, and to the Far East (Bischler 1988). In Africa (and the neighbouring islands), it is known from Algeria, Ethiopia, the Azores, Terceira and Réunion. Bischler-Causse (1993a) states that its presence on the Canary Islands, Madeira and in Morocco needs confirmation. A specimen from Madeira, *Tavares* (LISU) was seen by me, and its archegoniophores were studied and are illustrated in Figure 5L–R. The presence of *M. paleacea* on Madeira is thus confirmed. Bischler-Causse (1993a) thought that the single specimen, *Rankin 206* (BM), from the vicinity of Pilgrim's Rest, South Africa, that she had seen, might have been mislabelled. A computer printout at PRE, however, revealed that several other bryophytes were collected by Rankin in the same area, with collecting numbers both lower and higher than the one referred to, so that it was

unlikely to have been mislabelled. I have recently also collected it near Pilgrim's Rest (Figure 3) on a steep earth bank of the Blyde River, where it grew down to the water's edge together with *M. debilis*. The plants were sterile unfortunately, as was Rankin's collection, but both had cupules. As noted above, archegoniophores from Madeira were used for the description and illustrations, but no antheridiophores were available for study.

In the Far East a subspecies, *M. paleacea* subsp. *dip-tera* (Nees & Mont.) Hatt., is recognized (Bischler-Causse 1989a). It is distinguished from subsp. *paleacea* by the epidermal pores of the thallus usually being surrounded by 7 or 8 rings of cells, by the frequent presence of non-functional female receptacles and by the marginal cells of the median scale appendage having the long axis oblique to perpendicular to the margins (not parallel to).

Marchantia paleacea subsp. *paleacea* is regarded as morphologically stable and can be distinguished from the other species of subgenus *Chlamidium* by its cruciate epidermal pores and its cupules which have margins with ciliate lobes. The appendage of the median scales is ovate to orbicular. Schuster (1992) regards *M. berteriana* as the closest ally to *M. paleacea*, because it also has cruciate epidermal pores and its cupules have margins with triangular lobes bearing teeth (or cilia) as well. *M. berteriana* is however, classified in subgenus *Marchantia*.

Marchantia section Chlamidium

Thallus with branches (6.0–)7.0–8.5 (–10.0) mm wide, generally rather remotely spaced and narrowly divergent. *Dorsal epidermis* without papillae; air pores with inner opening bordered by cells, their inside walls convex to nearly straight or with short, rounded processes. *Median scales* with appendage ovate to orbicular or broadly triangular, apically rarely obtuse, mostly acute, sometimes shortly apiculate, basally rounded or cordate, width across broadest part $375\text{--}530 \mu\text{m}$, margins entire or sometimes bluntly toothed; with 1 or 2 oil cells, rarely more numerous. *Cupules* with ciliate margins, cilia up to 6 or 7 cells long and 3 cells wide basally, exteriorly sometimes also with several cilia.

Dioicous. *Antheridiophore* on stalk which mostly lacks bands of air chambers but with 2 or 3 rhizoid furrows; basally surrounded by quite large scales, often with an appendage; receptacle palmate, shallowly to deeply dissected into 6–8 (–10) rays, dorsal surface with or without papillae. *Archegoniophore* on stalk having 2 bands of air chambers and 2 rhizoid furrows; basally surrounded by quite large scales, often with an appendage and rather similar to median scales of thallus; receptacle with or without small, median projection dorsally, shortly divided into 9–11 rather flat lobes, sometimes basally narrow, widening slightly toward truncate apex; involucre margins shortly to long ciliate. *Spores* $20\text{--}30 \mu\text{m}$ in diameter, ornamentation on distal face with wide, irregular, smooth ridges forming incomplete areolae filled with nodules; proximal face entirely covered with nodules.

Of the southern African taxa, only *M. pappeana* belongs in this section. The ornamentation of its spores is

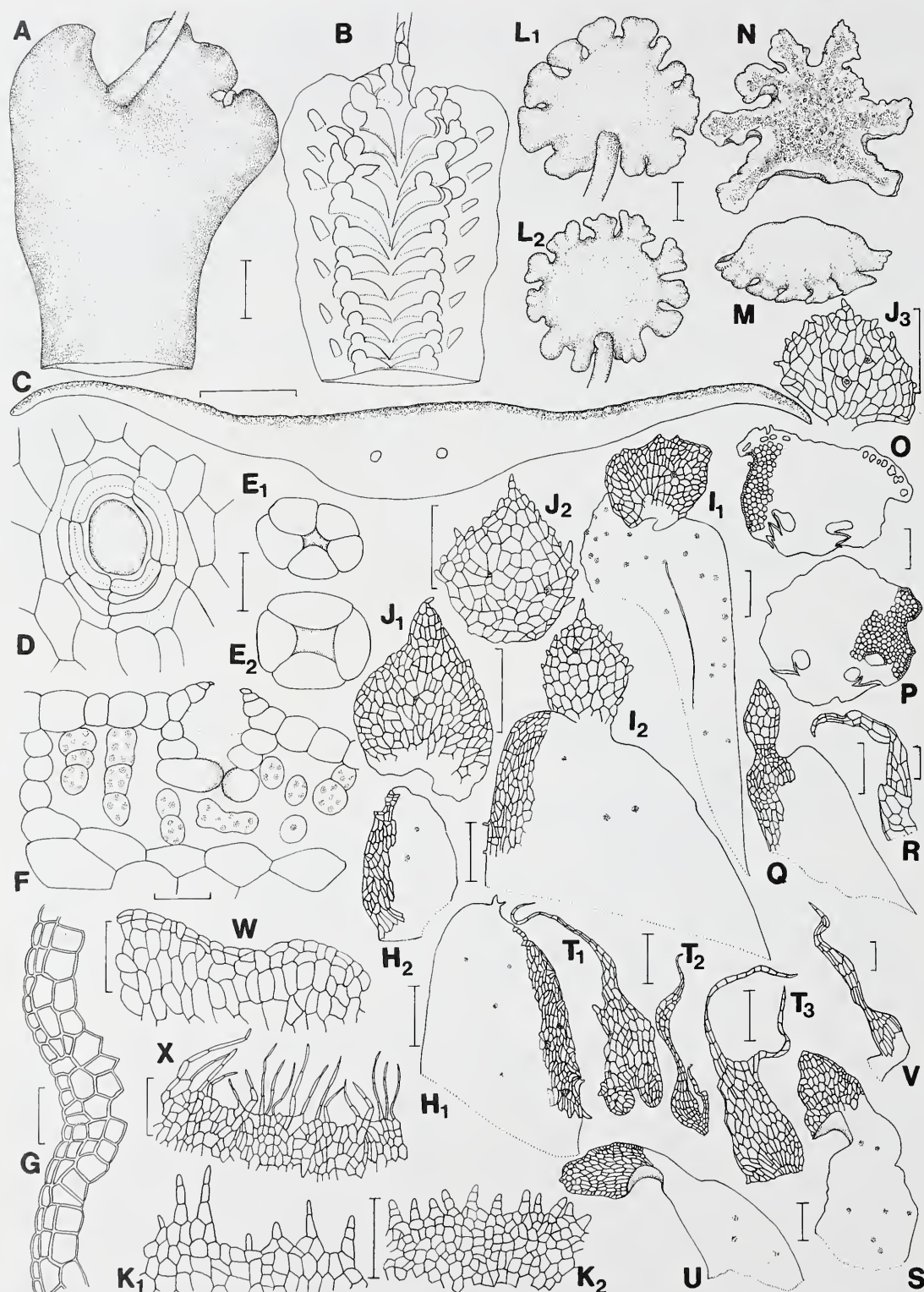


FIGURE 6.—*Marchantia pappeana* Lehm. subsp. *pappeana*. A–G, thallus. A, B, apical branch: A, dorsal face; B, ventral face. C, t.s. of branch. D–F, air pore from above; E₁, E₂, from below; F, t.s. of dorsal epidermal cells and part of air chamber. G, margin. H–J, scales: H₁, H₂, laminal; I₁, I₂, median; J₁–J₃, appendages of median scales. K₁, K₂, margins of eupules; L–Q, receptacles: L₁, L₂, ♀ from above; M, ♀ from side; N, ♂; O, t.s. of ♀ stalk; P, t.s. of ♂ stalk; Q, median scale of ♂. R–V, scales: R, along ♂ stalk; S, foot of ♂ stalk; T₁–T₃, ♀ receptacle; U, foot of ♀ stalk; V, along ♀ stalk. W, margin of ♂ ray; X, margin of involucre. A, G, H₁, I₂, J₂, K₁, L₁, L₂, M, T₁–T₃, X, Koekemoer 1050; B, C, F, J₃, K₂, N, Perold & Koekemoer 2918; D, O, V, Burgoyne 2068; E₁, S, H. Anderson 1261; E₂, I₁, J₁, H₂, Perold & Koekemoer 2841; P–R, W, Hilliard & Burt 15460; U, H. Anderson CH13278. Scale bars: A, B, L–M, 2 mm; C, 1 mm; D–G, 50 µm; H–V, X, 250 µm; W, 100 µm.

referred to as the *chenopoda* type: there are, however, two other spore coat ornamentation types in the section (Bischler-Causse 1989a). The section is distinct in the shape of the female receptacle and in the ciliate margins of the involucre and cupules.

4. *Marchantia pappeana* Lehm. in *Novarum et minus cognitarum stirpium*, Pugillus X: 21 (1857); Bischl.: 76 (1993a). Type: South Africa, 'In Prom. B. S. leg. Pappe', ex herb. Lehmann (RO, holo.?, G! ex herb. Univ. di Roma).

M. pappeana subsp. *pappeana* Bischl.: 82 (1993a).

M. flavescescens Steph. in Bonner: 107 (1953). Type: Fernando Pó, 1911 Mildbraed 6275 (G).

M. parviloba Steph.: 305 (1895); Vanden Berghen: 46 (1954); S.W. Arnell: 56 (1963). Type: Uganda, Runssoro, um 2 800 m, 10 Juli 1891, Stuhlmann 2368a (G, lecto. fide Vanden Berghen: 46 (1954); BM, isolecto. fide Bischl.: 82 (1993a)).

M. planiloba Steph.: 90 (1886); Henriques: '153, 154'; 181, 182 ('1886', 1887). Type: São Tomé, Cachoeira do Rio Manuel Jorge, circa S. Nicolau, 800 m, 1885, Moller 32 [G, lecto. fide Vanden Berghen: 52 (1960)].

M. planiloba Steph. var. *walteri* Burgeff: 276 (1943). Type: Tanzania, 'Nderema in Ost-Usambara, etwa 1 000 m, leg. H. Walter', syn. fide Bischl.: 83 (1993a).

M. stephanii Vanden Berghen: 50 (1954) [= *M. umbellata* Steph.: 305 (1895), nom. illeg.]. Type: Tanzania, Usambara, Holst 692 (FH, G), syn. fide Bischl.: 83 (1993a).

M. wilmsii Steph: 126 (1892). Type: South Africa, Transvaal, *McLea in Rehmann Hep. austro-afr. exs. 1* [PC, lecto. fide Vanden Berghen: 44 (1954); BM!; G, NY, S, isolecto. fide Bischl.: 84 (1993a)].

M. winkleri Steph. in Bonner: 112 (1953). Type: Cameroon, Winkler 270 (G).

Thallus medium-sized to large, rather distantly and irregularly branched, not ribbon-like or flat, apical segments oblong to obovate, light green to yellowish green, often purplish pink or deeply purple toward margins, or irregularly smudged with purple on dorsal surface, without dark median band (Figure 6A), margins undulate, scalloped, usually hyaline, occasionally purple, entire, mostly crisped; pores quite large and subdorsal air chamber walls visible from above and flecked with whitish oil cells, when wet; thallus margins rarely raised, not incurved when dry; in densely crowded and irregularly overlying mats. *Branches* with total length up to 50 mm, terminally 10–15 mm long and successive branches generally 10–13 mm apart, mostly narrowly to moderately divergent, (6.0–)7.0–8.5 (–10.0) mm wide, 740–925 µm thick over midrib, laterally thinning out into wings (Figure 6C); apex notched, with appendages of purple-brown median scales recurved over edge (Figure 6A); margins acute, thin; flanks sloping obliquely; ventral face medianly keeled, with rows of purple scales on either side, extending over 40–75% of thallus width (Figure 6B).

Dorsal epidermal cells unistratose, very rarely bistratose in patches, hyaline, mostly 5- or 6-sided (Figure 6D), 42.5–80.0 (–105.0) × 22.5–37.5 µm, thin-walled, not thickened at corners, rarely containing an oil body, in transverse section 25.0–32.5 µm thick; along margins 1–2(3) rows of cells, mostly narrowly rectangular (Figure 6G), 22.5–30.0 × 10.0–17.5 µm, sometimes shorter than broad, ± 17.5 × 35.0 µm, innermost third row of cells larger, 27.5–32.5 × 27.5 µm; air pores fairly numerous, dis-

tance between them (200–)325–575 µm, raised, compound, oval or round, (65–)90–105 × 70–100 µm, surrounded by 6 or 7 concentric rings of cells, 3 or 4 above epidermis and 2 or 3 projecting into air chambers (Figure 6F), innermost ring of upper cells, ± 50.0 × 7.5 µm, next 2 rows of cells ± 40.0 × 7.5–10.0 µm, partly overlying the outer, larger ring of 7 or 8 polygonal cells, up to 75.0 × 17.5 µm, inner opening with 4 or 5(6) bulging cells (Figure 6E₁, E₂), 30.0–42.5 × 12.5–15.0 µm, inner walls convex or almost straight, densely covered by dark granules. *Assimilation tissue* 60–90 µm thick, ¹/₁₂–¹/₈ as thick as thallus medianly, air chambers in a single layer, with 2 or 3 cells in vertical bounding walls, 27.5–42.5 × 17.5–30.0 µm, occasionally containing an oil body, ± 35 µm in diameter, air chambers 275–387 µm wide, crowded with chlorophyllose filaments (Figure 6F), 1–3-celled, often irregular in shape, 20.0–30.0 × 15.0–17.5 µm; storage tissue occupying ventral ⁷/₈–¹¹/₁₂ of thickness of thallus medianly, decreasing laterally, often with a wide, upper, central, purple-stained band, cells angular, closely packed, 25–50 µm wide, rather smaller below, but much larger laterally, sclerotic cells present or absent, mucilage openings few, up to 200 µm wide, or absent; rhizoids some smooth, width 15–45 µm, others pegged, 10–15 µm wide.

Median scales (Figure 6I₁, I₂) purple, in one row on either side of midrib, body obliquely triangular, 800–1125 µm high, 1430–1875 µm wide across arched base, mostly ending below in a long 'tail', central cells elongated, 5- or 6-sided, walls often sinuous, 92.5–107.5 × 30.0–37.5 µm, smaller toward margins and longer and narrower in 'tail', oil bodies scattered, margins sometimes with protruding papillae, ± 50.0 × 12.5 µm, scale narrowing upwards, deeply constricted where joined with appendage (Figure 6J₁–J₃), purple brown or reddish, ovate to orbicular or broadly triangular, apically rarely obtuse, mostly acute, sometimes shortly apiculate, 520–550 × 375–530 µm, apiculus with a vertical row of 2 or 3 cells, 35.0–62.5 × 20.0–27.5 µm, basally rounded or cordate, margins entire or sometimes bluntly toothed, teeth 32.5–50.0 × 20.0–30.0 µm, marginal cells 50.0–62.5 × 17.5–37.5 µm, only slightly smaller than inner cells, 4–7-sided, 75.0–87.5 × 32.5–42.5 µm, oil cells solitary, rarely more numerous. *Laminal scales* (Figure 6H₁, H₂) mauve with hyaline base, in one row at lateral sides of median scales, obtusely triangular, (750–)980–1125 × (360–)630–1075 µm, cells 4–7-sided, 45.0–70.0 × 20.0–27.5 µm, smaller toward margins, oil cells scattered, appendage lacking, margins often with protruding papillae. *Cupules* with margins ciliate (Figure 6K₁, K₂), cilia (122.5–)180.0–315.0 µm or up to 6(7) cells long, top cell 45.0–67.5 × 15.0 µm, lower cells 30.0–75.0 × (17.5–)22.5–32.5 µm, basal cells ± 50.0 × 62.5 µm, sometimes 2 adjoining, ± 75.0 × 17.5–30.0 µm, exterior surface occasionally also ciliated.

Dioicous. Antheridiophore arising mostly from apex of terminal segment of main branch, raised on stalk, 9–18 (–32) mm long, diameter 775–925 µm, in transverse section (Figure 6P) with one row of small cortical cells, (12.5–)15.0–20.0 × (12.5–)15.0–17.0 µm, outer wall slightly thickened, medullary cells larger, up to 60 µm wide, but in between with smaller cells, ± 20 µm wide, air chambers mostly absent, with 2(3) rhizoid furrows, ± 150 µm wide; *scales at base of stalk* (Figure 6S), 1 or 2, hyaline, broadly triangular, 1000–1150 × 550–750 µm,

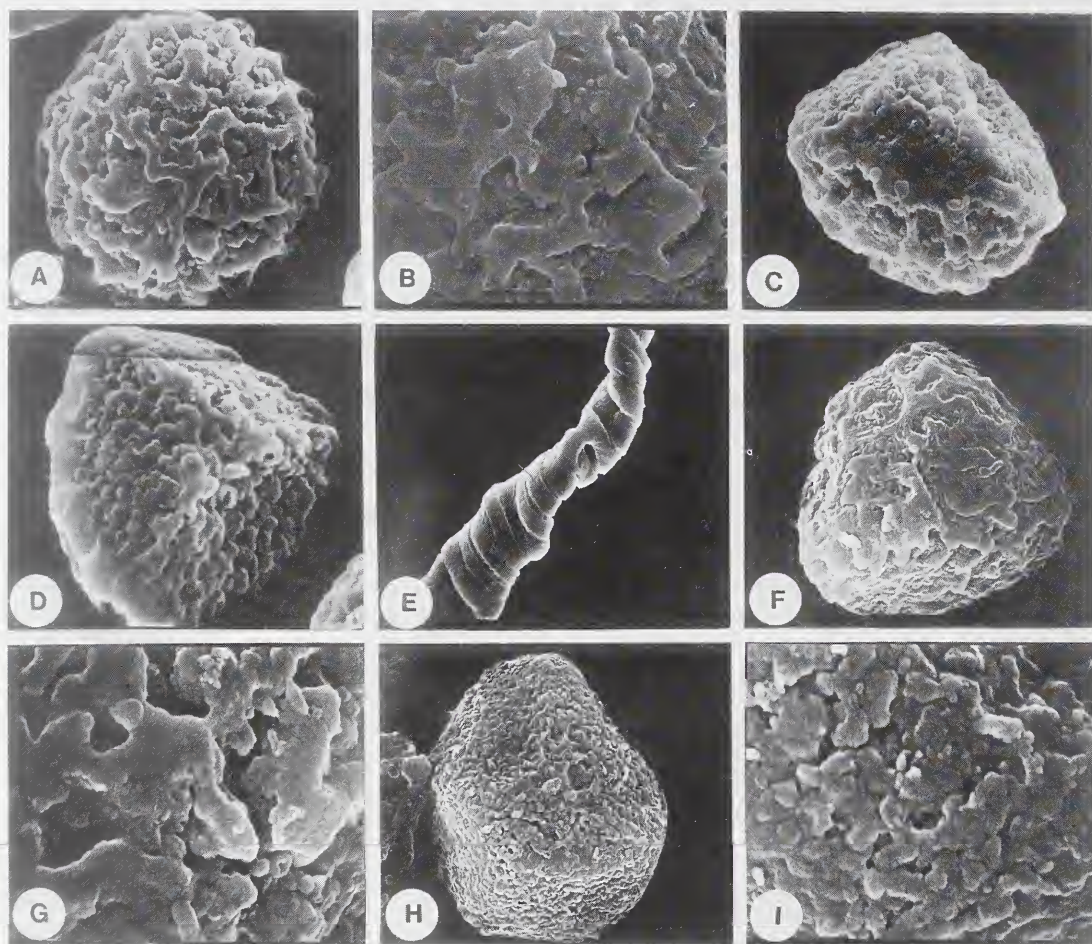


FIGURE 7.—SEM micrographs of spores. A–E, *Marchantia pappeana*, H. Anderson CH13278: A, distal face; B, part of distal face much enlarged; C, side view; D, proximal face. E, part of elater, much enlarged. F–I, *M. debilis*, Preuss s.n.: F, distal face; G, part of distal face much enlarged; H, proximal face; I, part of proximal face, much enlarged. A, $\times 1233$; B, $\times 2340$; C, D, $\times 1200$; E, $\times 740$; F, $\times 1412$; G, I, $\times 5148$; H, $\times 1373$.

sometimes with appendage, $\pm 675 \times 500 \mu\text{m}$, partly or not constricted at base, cells $75\text{--}80 \times 30\text{--}55 \mu\text{m}$, slightly smaller lower down; *scales along length of stalk* (Figure 6R), narrowly triangular and tapering toward apex, up to $1300 \mu\text{m}$ long, base $\pm 175 \mu\text{m}$ wide, cells $62.5\text{--}100.0 \times 27.5\text{--}37.5 \mu\text{m}$; *receptacle* $9\text{--}14 \text{ mm}$ in diameter, palmate, divided into 6–8 rays (Figure 6N), $1.7\text{--}3.4 \text{ mm}$ long, $\pm 3.5 \text{ mm}$ wide, basal sinus $120^\circ\text{--}140^\circ$, margins of rays reddish, undulating, entire (Figure 6W), outer cells long and narrow, $\pm 27.5 \times 10.0 \mu\text{m}$, here and there alternating with wider cells, $25.0\text{--}37.5 \times 25.0 \mu\text{m}$; *median scales* on ventral side of rays brownish, obtusely triangular, body $\pm 750 \times 500 \mu\text{m}$, cells $55\text{--}75 \times 25 \mu\text{m}$, mostly with appendage tapering to acute apex (Figure 6Q), $350\text{--}375 \times 125\text{--}250 \mu\text{m}$, cells $\pm 62.5 \times 37.5 \mu\text{m}$.

Archegoniophore generally arising from apex of terminal segment of main branch, raised on stalk, $16\text{--}32\text{--}(60) \text{ mm}$ long, diameter $850\text{--}1050 \mu\text{m}$, wider across chambers, $\pm 1250 \mu\text{m}$, in transverse section (Figure 6O) with one row of small, rounded, cortical cells, $15.0\text{--}25.0 \times 12.5\text{--}25.0 \mu\text{m}$, outer wall slightly thickened, medullary cells angular, $\pm 50 \mu\text{m}$ wide, with smaller, $\pm 20 \mu\text{m}$ wide cells in between, air chambers in 2 separate and opposite

bands $\pm 500 \mu\text{m}$ wide, containing several small air chambers, $\pm 62 \mu\text{m}$ high, also with 2 rhizoid furrows, $\pm 85 \times 195 \mu\text{m}$; *scales at base of stalk*, 1 or 2 present (Figure 6U), larger, $\pm 1350 \times 850 \mu\text{m}$, shape irregular, cells $87.5\text{--}107.5 \times 25.0 \mu\text{m}$, often with $\pm$ triangular appendage, slightly constricted at base or hardly so, $750\text{--}900 \times 500\text{--}550 \mu\text{m}$, cells $92.5\text{--}137.5 \times 25.0\text{--}37.5 \mu\text{m}$, 4–7-sided, walls straight, shorter along margin, $37.5\text{--}42.5 \times 37.5\text{--}50.0 \mu\text{m}$; *scales along length of stalk* (Figure 6V), hyaline strands, $1300\text{--}1950 \times 70\text{--}200 \mu\text{m}$, tapering, apically filamentous; *receptacle* $(6.5\text{--})8.0\text{--}11.0 \text{ mm}$ in diameter, sometimes with small, rounded, median projection dorsally, shortly and $\pm$ symmetrically divided into 9–11 lobes (Figure 6L₁, L₂, M) (occasionally 1 or 2 lobes replaced by male rays), $1.4\text{--}1.7 \text{ mm}$ long, base narrow, $1.0\text{--}1.25 \text{ mm}$, widening to $2.1\text{--}3.0 \text{ mm}$, toward truncate apex, basal sinus $\pm 30^\circ$; margins of involucre hyaline, ciliate (Figure 6X), cilia delicate, sometimes collapsed, $187.5\text{--}200.0 \mu\text{m}$ long, consisting of cells, $62.5\text{--}100.0 \times 17.5\text{--}25.0 \mu\text{m}$, occasionally base broader, up to $37.5 \mu\text{m}$ wide, inner cells angular, $50.0\text{--}62.5 \times 32.5 \mu\text{m}$, with numerous large oil bodies; *scales of receptacle* mauve or hyaline, tapering toward apex, sometimes abruptly so, occasionally forked (Figure 6T₁–T₃), up to $3250 \times 250 \mu\text{m}$,

cells 4–7-sided, $75.0\text{--}137.5 \times 37.5\text{--}40.0\text{ }\mu\text{m}$, filamentous apices $\pm 450\text{ }\mu\text{m}$ long, with apical cell conical, $\pm 50 \times 15\text{ }\mu\text{m}$, lower cells $\pm 65 \times 30\text{ }\mu\text{m}$, several oil cells present, $\pm 50.0 \times 32.5\text{ }\mu\text{m}$, and marginally with unicellular papillae, $\pm 37.5 \times 15.0\text{ }\mu\text{m}$. *Spores* $22.5\text{--}30.0\text{ }\mu\text{m}$ in diameter, triangular-globular, yellow-brown, distal face (Figure 7A, B) with irregular, $\pm$ smooth ridges, forming incomplete areolae filled with nodules; proximal face (Figure 7C, D) with faint triradiate ridge, each facet densely covered with nodules, some discrete, others confluent, narrowly winged, margin entire. *Elaters* yellow-brown, up to $825 \times 7.5\text{ }\mu\text{m}$, tapering toward ends, $5.0\text{ }\mu\text{m}$ wide, bispiral (Figure 7E). *Chromosome number*: $n = 18$ (Bischler-Causse 1993a).

Although *M. pappeana* had already been described by Lehmann in 1857 and was mentioned by Stephani (1898–1900), the name has been neglected by subsequent authors and specimens in most herbaria, including PRE, are labelled as *M. parviloba*, *M. planiloba* or *M. wilmsii*. The species is listed as *M. parviloba* in Magill & Schelpe (1979). Several authors had suspected, however, that *M. parviloba* was synonymous with *M. planiloba* (Vanden Berghen 1965; Jones & Harrington 1983). Bischler-Causse (1993a) found that only seven of the 18 specimens cited by Stephani, belong to *M. pappeana* and of the 30 kept in his herbarium, only 11 belong here.

Arnell (1963) mistakenly considered *M. pappeana* to be a synonym of *M. berteriana*. He may, however, have been misled by a specimen in S (where Lehmann's original collections are kept) which was labelled *M. pappeana*, but actually contains *M. berteriana*, as was shown by Bischler-Causse (1993a). Arnell (1963) merely surmised that *M. parviloba* would be found in the northern parts of South Africa, but he had probably only seen specimens from Zaïre [Congo], Tanzania [Tanganyika] and Zimbabwe [Southern Rhodesia].

Marchantia pappeana often grows in the same localities as *M. debilis*, on vertical soil banks of streams, at waterfalls, at sluice canals, very rarely on rotting wood or on rocks, in open grassland or in forests, sometimes in deep shade.

It is widely distributed in tropical Africa, Bischler-Causse (1993a) reporting it from the Cape Verde Islands to Ethiopia and south to southern Africa, generally at an altitudinal range of 1 000–2 500 m. In southern Africa (Figure 8) it is known from the Northern Province [Northern Transvaal] and Eastern Transvaal, Gauteng [PWV], Swaziland, Kwazulu-Natal, eastern [Orange] Free State and Lesotho. It has also been collected at Kirstenbosch Botanical Garden a number of times and the type specimen is from Promontorium Bonae Spei.

Of the 50 specimens examined, 62% had cupules, 20% had antheridiophores and 34% had archegoniophores; only 6% had both. Morphologically the species is variable, exhibiting this trait even among specimens from the same geographical area. Generally, however, it can be distinguished by being larger than *M. debilis* and by lacking a dark median line on the dorsal surface of the thallus; its median scale appendages are large and often marginally toothed, with the inner cells large, presenting a 'loose' appearance; its cupules have longer cilia; the female re-

ceptacle is shortly divided into rays and the involucre margin is ciliate; androgynous branches in the female receptacle are sometimes present.

Marchantia pappeana subsp. *pappeana* is distinguished from *M. pappeana* subsp. *robusta*, a close relative in South India and Sri Lanka, by the latter having numerous sclerotic cells and mucilage cavities in the thallus; oil bodies in the median scale appendages are, however, absent.

Marchantia section Papillatae Bischl. in Cryptogamie, Bryologie et Lichénologie 10: 69 (1989); Bischl.: 99 (1993a). Type: *M. papillata* Raddi (Pl. lecto., Bischl.: 95 (1984).

Thallus with branches rather narrow, (2.1–)4.5–7.3 mm wide, ribbon-like, often quite regularly spaced, moderately to widely divergent. *Dorsal epidermis* without papillae; air pores with inner opening bordered by cells, their inside walls convex or straight. *Median scales* with appendage orbicular or ovate, apically acute or apiculate, seldom obtuse, basally rounded, width across widest part 275–340 μm , margins toothed; oil cells absent. *Cupule* margins with short cilia, 3(4) cells long and 1 or 2 cells wide basally, external surface without papillae.

Dioicous. *Antheridiophore* on stalk without or with 1 or 2 bands of much reduced air chambers and 2 rhizoid furrows, basally surrounded by smaller, narrowly triangular scales, sometimes divided above into filamentous segments; receptacle smallish, palmate, asymmetric and deeply divided into (4–)5–7 rays, dorsal surface without papillae. *Archegoniophore* on stalk with single band of air chambers (in African taxon) and 2 rhizoid furrows; basally surrounded by smaller, $\pm$ triangular scales, gradually tapering to filiform apex; receptacle smallish, with a rounded median projection dorsally, deeply divided into 8–10 lobes, basally convex and costate, apically broadened; involucre margins entire or crenulate. *Spores* 25–32 μm in diameter, ornamentation on distal face with irregular coarse ridges, forming incomplete areolae filled with granules; proximal face densely verrucose.

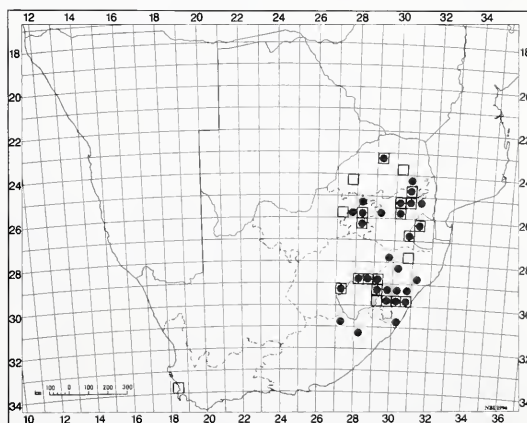


FIGURE 8.—Distribution of *M. pappeana* var. *pappeana*, □; and *M. debilis*, ●, in southern Africa.

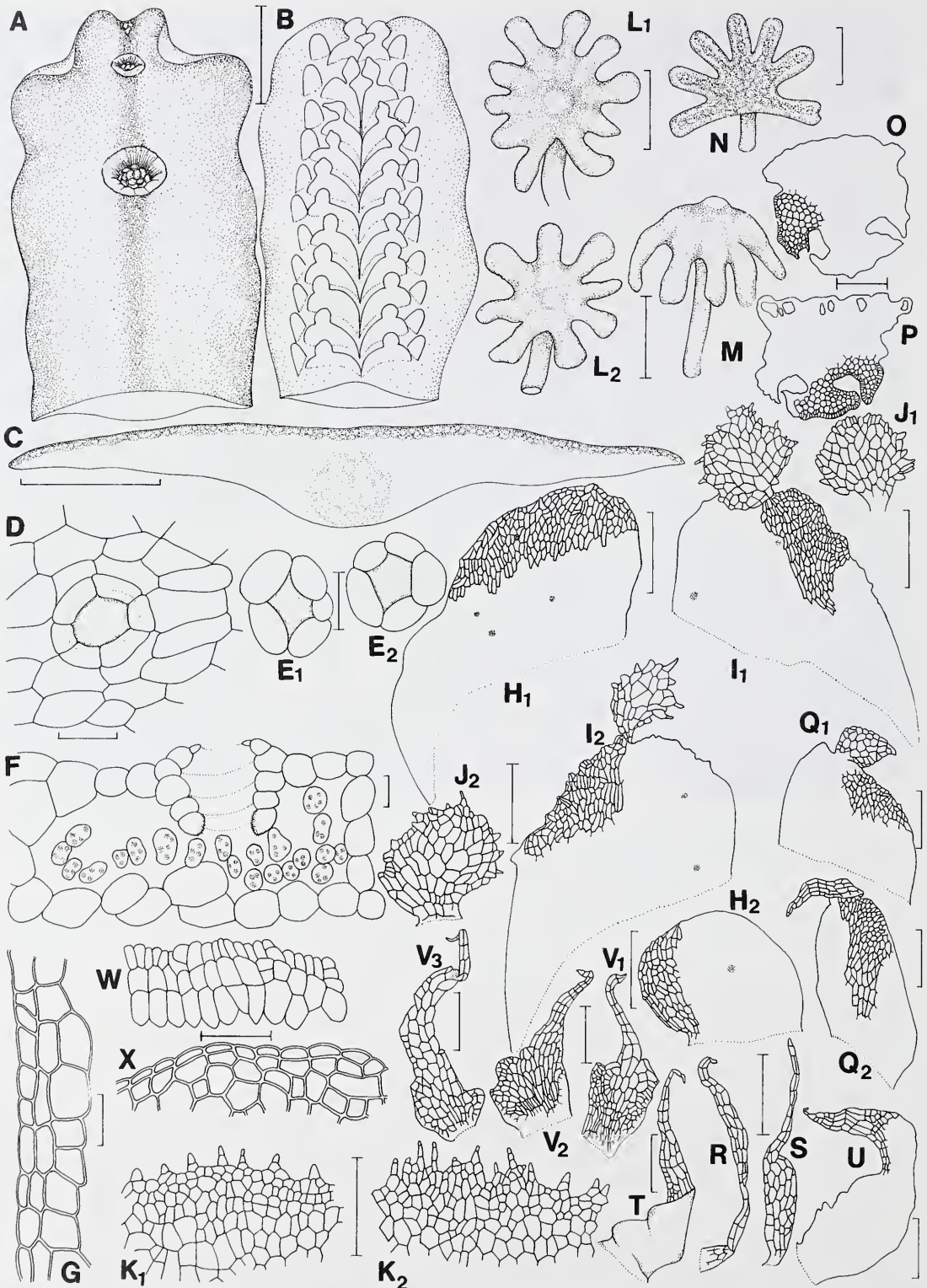


FIGURE 9.—*Marchantia debilis* Goebel. A–G, thallus. A, B, apical branch: A, dorsal face, with eupules; B, ventral face. C, t.s. of branch; D–F, air pore: D, from above; E₁, E₂, from below; F, t.s. of dorsal epidermal cells and air chamber. G, margin. H₁, H₂, laminal scales; I₁, I₂, median scales; J₁, J₂, appendages of median scales; K₁, K₂, margins of eupules. L–Q, receptacles: L₁, L₂, ♀ from above; M, ♀ from side; N, ♂. O, t.s. of ♂ stalk; P, t.s. of ♀ stalk; Q₁, Q₂, median scales of ♂ ray. R–V, scale: R, along ♂ stalk; S, along ♀ stalk; T, base of ♀ stalk; U, base of ♂ stalk; V₁–V₃, ♀ receptacle. W, margin of ♂ ray; X, margin of involucre. A, H. Anderson CH1223; B, R, U, W, X, Mogg 6172; C–G, H₂, J₁, K₁, Condy 90; H₁, I₁, I₂, K₂, Bester 2544; J₂, Glen 1940; L₁, L₂, M, P, S, T, Dieterlen 850; N, Sim CH1345; O, S.M. Perold 2891; Q₁, Q₂, V₁–V₃, S.M. Perold 3048. Scale bars: A–B, L–N, 2 mm; C, 1 mm; D–G, 50 µm; H–K₂, O–V₃, 250 µm; W, X, 100 µm.

Only *M. debilis* of the southern African taxa belongs to this section. Bischler-Causse (1993a) states that it is closest to the Asiatic species, *M. emarginata* subsp. *tosana*. The ornamentation of the spores is of the *papillata* type. The section differs from sect. *Paleaceae* and sect. *Chlamidium* in the shape of the female receptacle, with the lobes costate basally and broadened apically.

5. *Marchantia debilis* Goebel in Organographie der Pflanzen. 1. Bryophyten 2, edn 2: 901 (1915); Bischl.: 100 (1993a). Type: Cameroon, Urwaldgebiet von Bipindi, Zenker; *Flora von Kamerun* exs. 1339 (BM!, BR, E, F, G, GOET, M, S, iso.).

M. chevalieri Steph. in Bonner: 103 (1953). Type: Ivory Coast, Haute Côte d'Ivoire, pays Djola, environs de Ona, 4-1909, *Chevalier s.n.* (G, PC).

Thallus smallish to medium-sized, rather flat and ribbon-like, apical segments oblong or broadly lingulate, green or occasionally purplish all over, when much exposed to bright sun, usually with a narrow, dark, broken, longitudinal median band dorsally (Figure 9A), margins narrowly reddish purple or hyaline, entire; pores quite small, subdorsal air chamber walls visible from above, when wet; thallus margins not raised or incurved, sometimes with slight longitudinal indentation along midline and apex occasionally incurved, when dry; in crowded, overlying patches or occasionally in partial rosettes, up to 75 mm across, repeatedly pseudodichotomously furcate, often rather regularly. *Branches* with total length up to $\pm$ 38 mm, terminally 5-12 mm long and successive branches 5-7(-9) mm apart, mostly moderately to widely divergent, 4.5-7.3 mm wide, 675-850 μ m thick over midrib, laterally thinning out into wings (Figure 9C); apex notched, with appendages of several reddish brown or purplish median scales recurved over edge; margins acute, thin, occasionally slightly crisped, flanks sloping obliquely; ventral face medianly keeled and densely covered with long strands of rhizoids, on either side with rows of purple scales extending over 70% or more of thallus width (Figure 9B).

Dorsal epidermal cells unistratose, rarely bistratose in patches, mostly hyaline, polygonal, (4-)5-7-sided, 37.0-62.5 $\times$ 22.0-32.0 μ m, thin-walled, not thickened at corners, in transverse section $\pm$ 17.5 μ m thick, occasionally containing a round oil body, $\pm$ 37.5 μ m in diameter, along margin 2 rows of narrow, $\pm$ rectangular cells, (10.0-)20.0-30.0(-37.5) $\times$ (7.5-)12.5-17.5 μ m (Figure 9G), innermost third row of cells mostly larger, 30.0-37.5 $\times$ 15.0-22.5 μ m; air pores quite numerous, (100-)215-275(-475) μ m distant from each other, raised, compound, oval, 37.5-62.5 $\times$ 40.0-52.5 μ m, surrounded by (4)5 or 6 concentric rings of cells (Figure 9D), 2 or 3 above epidermis and 2 or 3 projecting into air chambers (Figure 9F), innermost ring of upper cells $\pm$ 7.5 μ m wide, cells of middle ring $\pm$ 12.5 μ m wide and outermost ring with 6 or 7 larger cells, 35.0-62.5 $\times$ 17.5-22.5 μ m, somewhat variable in shape and partly overlying epidermal cells, inner opening (Figure 9E₁, E₂) with 4 or 5 rather swollen cells, 20-25 $\times$ 35-42 μ m, their inside walls $\pm$ convex or nearly straight. *Assimilation tissue* up to 150 μ m thick, $\pm$ $\frac{1}{6}$ as thick as thallus, air chambers in a single layer (Figure 9F), (105-)150-300 μ m wide, cells in bounding walls $\pm$ 32.5 $\times$ 17.5 μ m, crowded with densely

chlorophyllose, mostly 3-celled filaments, cells $\pm$ 20 $\times$ 15-25 μ m; storage tissue occupying ventral $\frac{5}{6}$ of thickness of thallus medianly, decreasing laterally, cells angular, medianly $\pm$ 50 μ m wide, compact, much enlarged laterally, sclerotic cells and mucilage cavities usually absent; rhizoids some smooth, 12.5-25.0 μ m, others pegged, 5.0-12.5 μ m wide.

Median scales (Figure 9I₁, I₂) brownish or purplish, in one row on either side of midrib, body $\pm$ obliquely triangular, up to 625 μ m long, base slightly arched, its width up to 3000 μ m, central cells 4-6-sided, walls often sinuous, 65.0-87.5 $\times$ 17.5-27.5 μ m, elongating and narrowing into long 'tail', (100.0-)137.5-182.5 $\times$ 12.5-17.5 μ m, oil bodies scattered, upper margins of scale serrate, as it narrows and becomes constricted where joined with appendage (Figure 9J₁, J₂), mauve generally, orbicular or ovate, apically acute or apiculate, rarely rounded, 350-375 $\times$ 275-340 μ m, median cells 67.5-75.0 $\times$ 30.0-37.5 μ m, smaller at toothed margin, $\pm$ 42.5 $\times$ 25.0 μ m, teeth conical, 1-celled, $\pm$ 37.5 $\times$ 20.0, or 2-celled, 45.0-62.5 $\times$ 15.0-42.5 μ m, oil bodies absent. *Laminar scales* (Figure 9H₁, H₂) brownish, in one row on lateral sides of median scales, $\pm$ ovate, rounded apically, lacking appendage, 450-560 $\times$ 430-670(-900) μ m, sometimes with short 'tail' (Figure 9H₁), cells (50.0-)58.5-67.5 $\times$ 17.5-25.0 μ m, walls often sinuous, oil bodies rare or absent, sometimes with marginal papillae, 50.0 $\times$ 12.5 μ m. *Cupules* with margins shortly ciliate (Figure 9K₁, K₂), some cilia unicellular, others 3 cells and up to 75 μ m long, apical cells conical, 20-30 $\times$ 15 μ m, basally 1 or 2 cells wide.

Dioicous. *Antheridiophore* arising from apex of terminal segment of main branch or of short lateral branch, on stalk (2.5-)7.0-16.0 mm long, diameter 625-700 μ m, in transverse section (Figure 9O) with 1 row of cortical cells, 17.5-22.5 $\times$ 10.0-17.5 μ m, outer wall curved, medullary cells angular, many up to 50 μ m wide, but in between smaller cells, only 17.5 μ m wide, air chambers much reduced, in single band, rhizoid furrows 2, $\pm$ 160 μ m wide; *scales at base of stalk* (Figure 9U), narrowly triangular, 750-1250 μ m long and 150-500 μ m wide at base, sometimes $\pm$ midway divided into (2)3 segments, only central part elongated and tapering to filamentous apical string of $\pm$ 5 single cells, top cell $\pm$ 30 $\times$ 10 μ m, basal one $\pm$ 45.0 $\times$ 27.5 μ m, cells in body of scale $\pm$ 92.5 $\times$ 27.5 μ m, margin with a few papillae, 37.5 $\times$ 7.5 μ m; *scales along length of stalk* filiform (Figure 9R), up to 1100 $\times$ 50 μ m, 2 or 3 cells wide, except for apical row of up to 5 single cells, and sometimes basally with short cellular strands at sides of long main one; receptacle 7.5-9.0 mm in diameter, asymmetric, above without antheridial papillae, divided into (4)5-7 rays (Figure 9N), 1.5-3.0 mm long and $\pm$ 1.2 mm wide at base, narrowing slightly to tip, basal sinus $\pm$ 130°, margins undulating, entire (Figure 9W), hyaline, cells in 1 or 2 rows, rectangular, 17.5-32.5 $\times$ 10.0-25.0 μ m; median scales on ventral side of rays (Figure 9Q₁, Q₂) hyaline or mauve, obtusely triangular, up to 1000 $\times$ 670 μ m, cells 4-6-sided, 35.0-62.5(-100.0) $\times$ 20.0-27.5 μ m, at margin with some papillae, sometimes with an apical appendage, constricted at its base or not, narrowly to broadly triangular, 300-430- $\times$ 100-200 μ m, brownish with mauve cell walls, cells 50-60 $\times$ 25-35 μ m, smaller toward apex, 20 $\times$ 15-22 μ m.

Archegoniophore at apex of terminal segment of main branch or of short lateral branch, raised on stalk, 9–16 mm long, diameter 400–550 µm, in transverse section (Figure 9P) with 1 row of cortical cells, $\pm 12.5 \times 22.5$ µm, medullary cells $22\text{--}40 \times 15\text{--}30$ µm, with 2 rhizoid furrows, $\pm 75 \times 130$ µm, and mostly a single band of air chambers, the latter up to 85.0×37.5 µm each, rarely 2 bands or a split band present; *scale(s) at base of stalk* (Figure 9T), brownish, $\pm$ triangular, $900\text{--}1000 \times 400\text{--}450$ µm, apex filiform with 3 or 4 single cells in a row, $\pm 32.5 \times 12.5$ µm, then widening gradually below, upper cells thick-walled, $50.0\text{--}55.0 \times 27.5\text{--}37.5$ µm, thinner-walled below, sometimes with short appendage at the side; *scales along length of stalk* (Figure 9S) scattered, $\pm 700 \times 112$ µm, narrowing above to ± 35 µm wide, cells $\pm 75 \times 15$ µm; *receptacle* (3.5)–4.5–7.0(9.0) mm in diameter, dorsally with a rounded projection medianly (Figure 9L₁, L₂, M) and deeply divided into 8–10 lobes, 0.8–1.25 mm long, narrower at base and widening toward apex, basal sinus $40^\circ\text{--}60^\circ$; margins of involucre hyaline, entire or crenulate, cells rectangular across to 5-sided (Figure 9X), $15.0\text{--}22.5 \times 27.5\text{--}37.5$ µm; *scales of receptacle* (Figure 9V₁–V₃) hyaline or yellow-brown or purple, $800\text{--}1000 \times 330\text{--}370$ µm, irregularly shaped, cells $75.0\text{--}100.0 \times 37.5\text{--}42.5$ µm, 5- or 6-sided, thick-walled, at basal margin smaller, $\pm 32.5 \times 15.0$ µm, thin-walled and sinuous, at apex 3 cells in a row, top cell conical, $40\text{--}75 \times 10\text{--}12$ µm, gradually widening lower down and sometimes with filiform appendage at the side. *Spores* $25.0\text{--}32.5$ µm in diameter, faintly triangular-globular, brown, distal face (Figure 7F, G) with irregular, coarse ridges, forming incomplete areolae, spaces between filled with granules; proximal face (Figure 7H, I) with triradiate mark hardly visible, facets densely verrucose. *Elaters* brown, up to $295 \times \pm 7.5$ µm, bispiral. *Chromosome number*: $n = 9$ (Bischler-Causse unpublished).

Bischler-Causse (1993a) states that this species, which is confined to Africa, has not been mentioned since its description by Goebel (1915) and that it occurs in various herbaria under 14 different names, but most commonly under *M. wilmsii*, *M. planiloba* and *M. chevalieri*. She also remarked that most authors considered *M. chevalieri* to be a synonym of *M. wilmsii*, but the lectotype of *M. wilmsii* (McLea!, syntype of Rehmann exsiccate) selected by Vanden Berghen (1954), belongs to *M. pappeana* and is an unfortunate choice.

The syntypes of *M. wilmsii* cited by Stephani are McLea in Rehmann Hep. austro-afr. exs. 1 and 'Prope Lydenburg et Greytown Dr Wilms'. Bischler-Causse (1993a) states that the McLea specimens are male and correspond to *M. pappeana*; the Wilms specimens from Lydenburg are female with cupules, or are sterile and also belong to *M. pappeana*, whereas the Greytown specimens are male with cupules and contain *M. debilis*. Bischler-Causse (1993a) concludes that Stephani probably had *M. pappeana* in mind, and not *M. debilis*, since he clearly described *M. pappeana* under the epithet *M. wilmsii*. In Stephani's herbarium, she found that 13 of the 16 '*M. wilmsii*' specimens belong to *M. pappeana* and only three to *M. debilis*.

It is indeed fortunate that Bischler, with her long and intimate experience with *Marchantia* species, was able to

resolve the taxonomy of this species, since neither Vanden Berghen (1954, 1965), nor Arnell (1963) nor Jones & Harrington (1983) managed to do so. Jones & Harrington (1983) regarded '*M. wilmsii*' as the commonest *Marchantia* species in tropical Africa and readily recognizable by the presence of the dark dorsal line. Specimens held at PRE, that belong here, were mostly identified as *M. wilmsii*. The species is also listed as such in Magill & Schelpe (1979) and in Arnold & De Wet (1993).

Marchantia debilis generally grows on damp soil on vertical stream banks or waterfalls, on mud (or occasionally on stones) of stream beds, at weirs, or sluice canals, on stone dam walls kept wet by spray, and on soil overlying sandstone or granite, in open grassland or in forests, sometimes in partial shade.

It is widely distributed in Africa, Bischler-Causse (1993b) stating it to occur from Morocco to South Africa, as well as on Réunion and also in the eastern part of Madagascar. In southern Africa (Figure 8) it occurs in the summer rainfall areas of the Northern Province [Northern Transvaal] and Eastern Transvaal, Gauteng [PWV], Swaziland, Kwazulu-Natal, eastern [Orange] Free State, Lesotho and Eastern Cape.

Most of the 98 specimens examined had cupules, but only 10% had antheridiophores and 16% had archegoniophores; 3% had both.

Sterile plants of *M. debilis* can be distinguished from *M. pappeana*, the species it has frequently been confused with, by the smaller size of the rather ribbon-like thallus, by the dark median line on the dorsal face of the thallus, by the smaller appendages of the median scales and by the shortly ciliate or almost entire margins of the cupules. Fertile plants should present no problem to identify as the smallish male and female receptacles, the latter with deeply divided lobes, are quite distinctive and the margin of the involucre is entire.

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SPECIMENS EXAMINED

H. Anderson 1223 (5), CH4497 (5), CH4501 (4), CH13278 (4), CH13279 (5) PRE. S.W. Arnell 1058 (2) BOL (sub *M. tabularis*); 1075 (2) BOL; 1234 (5) BOL.

Barnard CH 1315 (sub *M. tabularis*) (2) PRE. *Bester* 2544 (5) PRE. *Bews* CH1321 (sub *M. tabularis*) (2), CH1348 (5) PRE. *Bingham* 8181

(5) (*Zambia*) PRE. *Bolus* CH1319 (sub *M. tabularis*) (2) PRE. *Bosman* CH195 (5) PRE. *Bottomley* CH1335 (sub *M. wilmsii*) (4) PRE. *Breutel s.n.* (2) W. *Burgoyne* 1588, 2068 (4) PRE. *Burt* Davy 435 (5) PRE.

Child 26211 (2) BOL. *Cholnoky* 929 (sub *M. wilmsii*) (4) PRE. *Condy* 90 (5), CH13638 (4) PRE.

Dieterlen 850 (sub *M. polymorpha*) (5) PRE. *Doidge* CH54 (2) PRE. *Drège s.n.*, 8286 (2) W. *Duthie* CH1320 (sub *M. tabularis*) (2) PRE.

Ecklon 8284, 8289 W; G546, G2072/7G (typus) (2) G. *Edwards* CH1346 (sub *M. wilmsii*) (4) PRE. *Esterhuysen* 34979a (2) BOL. *Eyles* CH1311 (sub *M. tabularis*) (2) PRE.

Garside 6186 (2) PRE. *Geldenhuis* 1061, 1332 (2) PRE. *Germishuizen* 4411, 6031 (5) PRE. *Gerstner* 583 (5) PRE. *Glen* 1690, 1940, 2189, 2207 pp. (5) PRE; 2207 pp. (4) PRE; 3007 (5) PRE; 3009, 3012, 3125a (4) PRE; 3468, 3728 (1) PRE. *Guthrie* 52555 (2) BOL.

Hepburn CH1223, CH1343 (5) PRE. *Hilliard & Burtt* 15460 (sub *M. wilmsii*) (4) BOL.

Kluge 2442 (5) PRE. *Koekemoer* 1049 (5), 1050 (4) PRE. *Krauss* 8291 (sub *M. contracta*) (2) G.

Lambert 7 (5) PRE. *Lanham* 72 (sub *M. polymorpha*) (4) PRE. *Leendertz* 755c (sub *M. polymorpha*) (5) PRE. *Lübenan-Nestlé* SA269 (5) PRE.

McLea in Rehmann exs. 1 (sub *M. wilmsii*) (4) BM. *Marais* (*Duthie* 5163) (sub *M. wilmsii*) (4) BOL. *Mogg* CH159 (2) PRE; CH1193, CH4150, 4227, 6172 (5) PRE. *Moonsanny* 17 (NH 16194) (sub *M. wilmsii*) (4) PRE. *Morley* 298 (2) PRE.

Oliver 54680 (2) BOL. *Onderstall* 314 (5) PRE.

Pappe s.n. (typus) (4) G. *RO. Pattison* 14479 (2) BOL. *J.J. Perold*, CH13644 (4) PRE. *S.M. Perold*, 41, 154, 164, 166, 168, 245, 1073 (5) PRE; 2500 (4) PRE; 2549 (2) PRE; 2675 (Malawi), 2701, 2891 (5) PRE; 2926 (4) PRE; 2945, 3048, 3239, 3245 (5) PRE; 3246, 3250, 3251 (4) PRE; 3252 (5) PRE; 3260a (4) PRE; 3261–3263 (5) PRE; 3264, 3265 (3) PRE; 3266 (5) PRE; 3267, 3268 (4) PRE. *Perold & Koekemoer* 2841, 2848 (4) PRE; 2869, 2875, 2893, 2897 (5) PRE; 2918 (4) PRE; 3181 (5) PRE; 3181a (4) PRE; 3248 (Ledbury, England), 3249 (Wageningen,

Netherlands), CH13640 (1) PRE. *Pillans* 4047, 4048, 4233 (2) BOL. *Playford* CH1324 (sub *M. wilmsii*) (4) PRE. *Pole-Evans* 461 (5), CH1351 (sub *M. wilmsii*) (4) PRE. *Porter* CH3586 (5) PRE. *Potts* 27, CH1312 (2) PRE. *Preiss* 8282 (2) PRE. *Preuss* 1192 (Cameroon) (5) BM.

Rankin 206 (3) BM. *C. Reid* 816 (5) PRE. *Reichenbach* 354137 (2) W. *Reinecke* CH174 (5) PRE. *Rennie & Lambert* 22 (sub *M. polymorpha*) (4) PRE. *Rogers* TM 2269 (sub *M. polymorpha*) (4) PRE.

Scheepers 562 (sub *M. wilmsii*) (4) PRE. *Schelpé* 2048 (5) BOL; 4226 (sub *M. wilmsii*) (2) BOL; 3745 (sub *M. wilmsii*) (4) BOL; 5359 (sub *M. parviloba*) (Zimbabwe) (4) BOL; 25367, 52542 (sub *M. wilmsii*) (2) BOL. *Scott* CH3693 (5) PRE. *T.R. Sim* CH1313, CH1316–CH1318, CH1322 (sub *M. tabularis*) (2) PRE; CH1323 (sub *M. wilmsii*) (4) PRE; CH1325–CH1327, CH1329, CH1330, CH1333 (5) PRE; CH1339, CH1341 (sub *M. wilmsii*) (4) PRE; CH1342, CH1344, CH1345 (5) PRE; CH1347 (sub *M. wilmsii*) (4) PRE; CH1352, CH1353 (5) PRE; CH1356, CH1358 (sub *M. wilmsii*) (4) PRE. *SL* CH1308 (2) PRE. *Snook* 8746 (2) PRE. *Stokoe* 9468 (sub *M. wilmsii*) (2) BOL. *Strauss* CH13641 (4) PRE. *Symons* CH1337 (5) PRE.

C. Tavares, P 66716 (3) LISU. *Theron* 1339 (5) PRE. *Thorne* CH1309, CH1544, CH1353 (2) PRE.

Univ. Durban-Westville 54 (5) PRE.

Van Breda 1116 (2) PRE. *Van der Bijl* CH1332, CH1349, CH1354, NH16171, NH16175 (5) PRE. *Van Rooy* 1012 (5), 1653 (4), 2624 (5) PRE. *A.E. Van Wyk* 2066 (2) PRE. *Y. Van Wyk* 883 (2) PRE. *Veltman* 3, 5 (4) PRE; 12 (5), 90 (4) PRE. *Venter* 12200 (5) PRE. *Vorster* 1785, 1789 (5) PRE.

Wager CH3805 (sub *M. wilmsii*) (4) PRE. *Wagener* CH13341 (2) PRE. *Wavra* 10 (2) W.

Zenker 1339 (5) (typus) BM; 1898 (5) BR.

New combinations and a complete list of *Asparagus* species in southern Africa (Asparagaceae)

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Keywords: Asparagaceae, *Asparagus*, new combinations, southern Africa, taxonomy

ABSTRACT

With only flower sexuality differing, *Protasparagus* can not be separated from *Asparagus*, neither at generic nor at subgeneric level. No significant differences in the degree to which filaments were connivent were observed between species placed under *Myrsiphyllum* and those under *Protasparagus/Asparagus*. All southern African species of Asparagaceae are therefore reinstated under *Asparagus* and listed here without recognition of subgenera. Several new combinations are made.

UITTREKSEL

Met slegs die geslagtelikheid van die blomme wat verskil, kan *Protasparagus* nie van *Asparagus* geskei word nie, nóg op genus- nóg op subgenusvlak. Geen noemenswaardige verskille in die mate waartoe helmdrade saamneigend is, is waargeneem tussen spesies wat onder *Myrsiphyllum* geplaas is en dié onder *Protasparagus/Asparagus* nie. Alle Suider-Afrikaanse spesies van Asparagaceae word dus heringestel onder *Asparagus* en hier gelys sonder erkenning van subgenusse. Verskeie nuwe kombinasies word gemaak.

The family name Asparagaceae was proposed by Jus-sieu (1789), soon after the genus *Asparagus* was named by Linnaeus (1753). The debate on the division of the genus into separate genera or subgenera, was started by Willdenow (1808) with his description of the genus *Myrsiphyllum*, which was countered by Roemer & Schultes's (1829) treatment of *Asparagus* as a single genus. Kunth (1850) then not only subdivided the genus, but transferred it back to the Liliaceae. Baker (1875) continued the trend and it remained the standard treatment till Huber (1969) and Dahlgren & Clifford (1982) once again advanced the concept of separate genera and the family name. Asparagaceae.

Obermeyer (1983, 1984) adopted Kunth's (1850) division of *Asparagus* s.l. into three separate genera: *Myrsiphyllum* Willd., *Asparagus* L. with unisexual flowers and *Asparagopsis* Kunth for the bisexual southern African species, in preference to Baker's (1875) single genus with three subgenera, *Euasparagus* Baker (= *Asparagus*), *Asparagopsis* (Kunth) Baker and *Myrsiphyllum* (Willd.) Baker. As *Asparagopsis* had been used by Montagne (1840) for a genus of the Rhodophycaceae and was therefore an illegitimate homonym in Kunth's application, *Protasparagus* Oberm. (1983) was published. This stance was also taken in the treatment of the family for the *Flora of southern Africa* by Obermeyer & Immelman (1992).

Malcomber & Sebsebe (1993) came to the conclusion that, with only flower sexuality differing, *Protasparagus* and *Asparagus* could not be separated at generic level nor

even kept as separate subgenera, but rather, on the basis of the shared character of free filaments, *Protasparagus* and *Asparagus* belonged together in the subgenus *Asparagus*. Neither could *Myrsiphyllum* be a distinct genus on the strength of connivent filaments versus free ones in the rest of the Asparagaceae. This character was, however, sufficient to distinguish the taxon as a subgenus. They therefore proposed that *Asparagus* be the only genus in the Asparagaceae, with subgenera *Myrsiphyllum* and *Asparagus*, the latter including the species previously placed in *Protasparagus*.

We accept the treatment by Malcomber & Sebsebe (1993) with reservation. The absence of *A. juniperoides* Engl. and *A. multituberosus* R.A. Dyer from the list of species investigated by these authors, prompted further investigation. As the close relatives of these two species are in the subgenus with connivent filaments, it could be expected to find the same condition here. However, it could not be demonstrated that filaments were markedly connivent, and no significant differences were observed in the degree to which filaments were connivent in the two subgenera. Therefore, we prefer to refrain from dividing the southern African species of the genus into subgenera.

In addition to the new combination made by Malcomber & Sebsebe (1993), more new combinations as well as reinstatements are necessary for the southern African species of the genus *Asparagus*. The numbers next to the species names listed alphabetically below (comb. nov. numbers indented), are the species numbers allocated by Obermeyer & Immelman (1992); those in *Myrsiphyllum* being affixed with an 'M'.

53. *Asparagus acocksii* Jessop in Bothalia 9: 74 (1966).

Protasparagus acocksii (Jessop) Oberm.: 243 (1983); Oberm. & Immelman: 57 (1992).

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46. *Asparagus aethiopicus* L., Mantissa plantarum: 32 (1767).

Protasparagus aethiopicus (L.) Oberm.: 243 (1983); Oberm. & Immelman: 54 (1992).

19. *Asparagus africanus* Lam., Encyclopédie méthodique 1: 295 (1783).

Protasparagus africanus (Lam.) Oberm.: 243 (1983); Oberm. & Immelman: 35 (1992).

48. *Asparagus aggregatus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus aggregatus Oberm. in Oberm. & Immelman: 55 (1992).

M8. *Asparagus alopecurus* (Oberm.) Malcomber & Sebsebe in Kew Bulletin 48: 73 (1993).

Myrsiphyllum alopecurum Oberm.: 85 (1984); Oberm.: 78 (1992).

50. *Asparagus angusticladius* (Jessop) Fellingham & N.L. Mey. comb. nov.

Asparagus aethiopicus L. var. *angusticladius* Jessop: 69 (1966). *Protasparagus angusticladius* (Jessop) Oberm.: 243 (1983); Oberm. & Immelman: 56 (1992).

M2. *Asparagus asparagoides* (L.) W. Wight, Century Dictionary 2: 845 (1909).

Medeola asparagoides L.: 339 (1753). *Myrsiphyllum asparagoides* (L.) Willd.: 25 (1808); Oberm.: 78 (1984); Oberm.: 73 (1992).

51. *Asparagus aspergillus* Jessop in Bothalia 9: 71 (1966).

Protasparagus aspergillus (Jessop) Oberm.: 243 (1983); Oberm. & Immelman: 56 (1992).

2. *Asparagus bayeri* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus bayeri Oberm. in Oberm. & Immelman: 21 (1992).

17. *Asparagus bechuanicus* Baker in W.T. Thiselton-Dyer, Flora of tropical Africa 7: 429 (1898).

Protasparagus bechuanicus (Baker) Oberm. in Oberm. & Immelman: 33 (1992).

63. *Asparagus biflorus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus biflorus Oberm. in Oberm. & Immelman: 63 (1992).

34. *Asparagus buchananii* Baker in Kew Bulletin 1893: 211 (1893).

Protasparagus buchananii (Baker) Oberm.: 243 (1983); Oberm. & Immelman: 45 (1992).

8. *Asparagus burchellii* Baker in Journal of the Linnean Society of London, Botany 14: 618 (1875).

Protasparagus burchellii (Baker) Oberm. in Oberm. & Immelman: 27 (1992).

4a. *Asparagus capensis* L. var. *capensis*, Species plantarum, edn 1: 314 (1753).

Protasparagus capensis (L.) Oberm.: 243 (1983); Oberm. & Immelman: 23 (1992).

4b. *Asparagus capensis* L. var. *litoralis* Suess. & J. Karl in Mitteilungen der Botanischen Staatssammlung, München 1: 50 (1950); Jessop: 44 (1966).

Protasparagus capensis L. var. *litoralis* (Suess. & J. Karl) Oberm. comb. illeg. in Oberm. & Immelman: 24 (1992).

47. *Asparagus clareae* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus clareae Oberm. in Oberm. & Immelman: 54 (1992).

45. *Asparagus coddii* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus coddii Oberm. in Oberm. & Immelman: 53 (1992).

59. *Asparagus concinnus* (Baker) Kies in Bothalia 6: 178 (1951a).

Asparagus africanus Lam. var. *concinnus* Baker: 619 (1875). *Protasparagus concinnus* (Baker) Oberm. & Immelman: 61 (1992).

41. *Asparagus confertus* K. Krause in Botanische Jahrbücher 51: 449 (1914).

Protasparagus confertus (K. Krause) Oberm. in Oberm. & Immelman: 51 (1992).

18. *Asparagus cooperi* Baker in Gardeners' Chronicle 1: 818 (1874a).

Protasparagus cooperi (Baker) Oberm.: 243 (1983); Oberm. & Immelman: 33 (1992).

52. *Asparagus crassicladius* Jessop in Bothalia 9: 75 (1966).

Protasparagus crassicladius (Jessop) Oberm.: 243 (1983); Oberm. & Immelman: 57 (1992).

M9. *Asparagus declinatus* L., Species plantarum, edn 1: 313 (1753).

Myrsiphyllum declinatum (L.) Oberm.: 86 (1984); Oberm.: 78 (1992).

39. *Asparagus densiflorus* (Kunth) Jessop in Bothalia 9: 65 (1966).

Asparagopsis densiflora Kunth: 96 (1850). *Protasparagus densiflorus* (Kunth) Oberm. in Oberm. & Immelman: 49 (1992).

21. *Asparagus denudatus* (Kunth) Baker in Journal of the Linnean Society of London, Botany 14: 606 (1875).

Asparagopsis denudatus Kunth: 82 (1850). *Protasparagus denudatus* (Kunth) Oberm.: 243 (1983); Oberm. & Immelman: 36 (1992).

30. *Asparagus devenishii* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus devenishii Oberm. in Oberm. & Immelman: 41 (1992).

69. *Asparagus divaricatus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus divaricatus Oberm. in Oberm. & Immelman: 67 (1992).

29. *Asparagus edulis* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus edulis Oberm. in Oberm. & Immelman: 41 (1992).

10. *Asparagus exsertus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus exsertus Oberm. in Oberm. & Immelman: 29 (1992).

32. *Asparagus exuvialis* Burch., Travels in the interior of southern Africa 1: 432 (1822).

Protasparagus exuvialis (Burch.) Oberm.: 244 (1983); Oberm. & Immelman: 42 (1992).

32a. *Asparagus exuvialis* Burch. forma *ecklonii* (Baker) Fellingham & N.L. Mey. comb. nov.

Asparagus ecklonii Baker: 615 (1875). *Protasparagus exuvialis* (Burch.) Oberm. forma *ecklonii* (Baker) Oberm. in Oberm. & Immelman: 43 (1992).

33. *Asparagus falcatus* L., Species plantarum, edn 1: 313 (1753).

Protasparagus falcatus (L.) Oberm.: 244 (1983); Oberm. & Immelman: 43 (1992).

M12. *Asparagus fasciculatus* Thunb., Flora capensis, edn 2: 329 (1823).

Myrsiphyllum fasciculatum (Thunb.) Oberm.: 87 (1984); Oberm.: 80 (1992).

40. *Asparagus filicladus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus filicladus Oberm. in Oberm. & Immelman: 51 (1992).

11a. *Asparagus flavicaulis* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus flavicaulis Oberm. in Oberm. & Immelman: 29 (1992).

11b. *Asparagus flavicaulis* (Oberm.) Fellingham & N.L. Mey. subsp. *setulosus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus flavicaulis Oberm. subsp. *setulosus* Oberm. in Oberm. & Immelman: 30 (1992).

61. *Asparagus fouriei* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus fouriei Oberm. in Oberm. & Immelman: 62 (1992).

28. *Asparagus fractiflexus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus fractiflexus Oberm. in Oberm. & Immelman: 40 (1992).

3. *Asparagus glaucus* Kies in Bothalia 6: 229 (1951b).

Protasparagus glaucus (Kies) Oberm.: 224 (1983); Oberm. & Immelman: 23 (1992).

31. *Asparagus graniticus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus graniticus Oberm. in Oberm. & Immelman: 42 (1992).

68. *Asparagus intricatus* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus intricatus Oberm. in Oberm. & Immelman: 65 (1992).

M7. *Asparagus juniperoides* Engl. in Botanische Jahrbücher 10: 3 (1889).

Myrsiphyllum juniperoides (Engl.) Oberm.: 84 (1984); Oberm.: 78 (1992).

M4. *Asparagus kraussianus* (Kunth) J.F. Macbr. in Contributions from the Gray Herbarium 56: 17 (1918).

Myrsiphyllum kraussianum Kunth: 107 (1850); Oberm.: 80 (1984); Oberm.: 76 (1992).

42. *Asparagus krebsianus* (Kunth) Jessop in Bothalia 9: 74 (1966).

Asparagopsis krebsiana Kunth: 93 (1850). *Protasparagus krebsianus* (Kunth) Oberm.: 244 (1983); Oberm. & Immelman: 51 (1992).

16. *Asparagus laricinus* Burch., Travels in the interior of southern Africa 1: 537 (1822).

Protasparagus laricinus (Burch.) Oberm.: 244 (1983); Oberm. & Immelman: 33 (1992).

23. *Asparagus lignosus* Burm.f., Prodrum florum capensis: 10 (1768).

Protasparagus lignosus (Burm.f.) Oberm. in Oberm. & Immelman: 37 (1992).

20. *Asparagus longicladus* N.E. Br. in Kew Bulletin 1921: 298 (1921).

Protasparagus longicladus (N.E. Br.) B. Mathew: 181 (1989); Oberm. & Immelman: 36 (1992).

36. *Asparagus lynetteae* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus lynetteae Oberm. in Oberm. & Immelman: 47 (1992).

60. *Asparagus macowanii* Baker in Journal of the Linnean Society of London, Botany 14: 609 (1875).

Protasparagus macowanii (Baker) Oberm.: 244 (1983); Oberm. & Immelman: 62 (1992).

6. *Asparagus mariae* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus mariae Oberm. in Oberm. & Immelman: 24 (1992).

57. *Asparagus microraphis* (Kunth) Baker in Journal of the Linnean Society of London, Botany 14: 612 (1875).

Asparagopsis microraphis Kunth: 83 (1850). *Protasparagus microraphis* (Kunth) Oberm.: 244 (1983); Oberm. & Immelman: 59 (1992).

64. *Asparagus minutiflorus* (Kunth) Baker in Journal of the Linnean Society of London, Botany 14: 616 (1875).

Asparagopsis minutiflorus Kunth: 89 (1850). *Protasparagus minutiflorus* (Kunth) Oberm.: 244 (1983); Oberm. & Immelman: 64 (1992).

15. *Asparagus mollis* (Oberm.) Fellingham & N.L. Mey. comb. nov.

Protasparagus mollis Oberm. in Oberm. & Immelman: 32 (1992).

25. *Asparagus mucronatus* Jessop in Bothalia 9: 56 (1966).

Protasparagus mucronatus (Jessop) Oberm. in Oberm. & Immelman: 38 (1992).

27. *Asparagus multiflorus* Baker in Journal of the Linnean Society of London, Botany 14: 610 (1875).

Protasparagus multiflorus (Baker) Oberm.: 244 (1983); Oberm. & Immelman: 39 (1992).

M1. *Asparagus multituberosus* R.A. Dyer in Bothalia 6: 442 (1954).

Myrsiphyllum multituberosum (R.A. Dyer) Oberm.: 77 (1984); Oberm.: 73 (1992).

49. *Asparagus natalensis* (Baker) Fellingham & N.L. Mey. comb. nov.
Asparagus aethiopicus L. var. *natalensis* Baker: 272 (1896). *Protasparagus natalensis* (Baker) Oberm.: 244 (1983); Oberm. & Immelman: 56 (1992).
37. *Asparagus nelsii* Schinz in Bulletin de l'Herbier Boissier, Sér. I.4, App. 3: 44 (1896).
Protasparagus nelsii (Schinz) Oberm.: 244 (1983); Oberm. & Immelman: 48 (1992).
56. *Asparagus nodulosus* (Oberm.) Fellingham & N.L. Mey. comb. nov.
Protasparagus nodulosus Oberm. in Oberm. & Immelman: 59 (1992).
12. *Asparagus oliveri* (Oberm.) Fellingham & N.L. Mey. comb. nov.
Protasparagus oliveri Oberm. in Oberm. & Immelman: 30 (1992).
- M3. *Asparagus ovatus* T.M. Salter in Journal of South African Botany 6: 167 (1940).
Myrsiphyllum ovatum (T.M. Salter) Oberm.: 79 (1984); Oberm.: 75 (1992).
38. *Asparagus oxyacanthus* Baker in Journal of the Linnean Society of London, Botany 14: 625 (1875).
Protasparagus oxyacanthus (Baker) Oberm.: 244 (1983); Oberm. & Immelman: 48 (1992).
22. *Asparagus pearsonii* Kies in Bothalia 6: 179 (1951a).
Protasparagus pearsonii (Kies) Oberm.: 244 (1983); Oberm. & Immelman: 37 (1992).
14. *Asparagus pendulus* (Oberm.) Fellingham & N.L. Mey. comb. nov.
Protasparagus pendulus Oberm. in Oberm. & Immelman: 32 (1992).
55. *Asparagus plumosus* Baker in Journal of the Linnean Society of London, Botany 14: 613 (1875).
Protasparagus plumosus (Baker) Oberm.: 244 (1983); Oberm. & Immelman: 59 (1992).
35. *Asparagus racemosus* Willd., Species plantarum edn 4.2: 152 (1799).
Protasparagus racemosus (Willd.) Oberm.: 244 (1983); Oberm. & Immelman: 45 (1992).
- M11. *Asparagus ramosissimus* Baker in Gardeners' Chronicle new series 2: 6 (1874b).
Myrsiphyllum ramosissimum (Baker) Oberm.: 87 (1984); Oberm.: 79 (1992).
1. *Asparagus recurvispinus* (Oberm.) Fellingham & N.L. Mey. comb. nov.
Protasparagus recurvispinus Oberm. in Oberm. & Immelman: 19 (1992).
26. *Asparagus retrofractus* L., Species plantarum, edn 1: 313 (1753).
Protasparagus retrofractus (L.) Oberm.: 244 (1983); Oberm. & Immelman: 39 (1992).
65. *Asparagus rigidus* Jessop in Bothalia 9: 64 (1966).
Protasparagus rigidus (Jessop) Oberm.: 244 (1983); Oberm. & Immelman: 64 (1992).
24. *Asparagus rubicundus* P.J. Bergius, Descriptiones plantarum ex Capite Bonae Spei: 88 (1767).
Protasparagus rubicundus (P.J. Bergius) Oberm.: 244 (1983); Oberm. & Immelman: 38 (1992).
- M10. *Asparagus scandens* Thunb., Prodrum plantarum capensium 1: 66 (1794).
Myrsiphyllum scandens (Thunb.) Oberm.: 86 (1984); Oberm.: 79 (1992).
44. *Asparagus schroederi* Engl. in Botanische Jahrbücher 32: 97 (1903).
Protasparagus schroederi (Engl.) Oberm.: 244 (1983); Oberm. & Immelman: 53 (1992).
62. *Asparagus sekukuniensis* (Oberm.) Fellingham & N.L. Mey. comb. nov.
Protasparagus sekukuniensis Oberm. in Oberm. & Immelman: 63 (1992).
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Protasparagus stellatus (Baker) Oberm. in Oberm. & Immelman: 61 (1992).
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Protasparagus subulatus (Thunb.) Oberm.: 244 (1983); Oberm. & Immelman: 65 (1992).
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Dracaena undulata L.f.: 203 (1781). *Myrsiphyllum undulatum* (L.f.) Kunth: 109 (1850); Oberm.: 83 (1984); Oberm.: 77 (1992).

13. *Asparagus virgatus* Baker in Refugium botanicum 3: t. 214 (1870).

Protasparagus virgatus (Baker) Oberm. in Oberm. & Immelman: 31 (1992).

M5. *Asparagus volubilis* Thunb., Prodrum plantarum capensium 1: 66 (1794).

Myrsiphyllum volubile (Thunb.) Oberm.: 82 (1984); Oberm.: 76 (1992).

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The taxonomic history of the Ricciaceae (1937–1995) and a classification of sub-Saharan Ricciae

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Keywords: classification, groups, history, Ricciaceae, sections, species, subgenera, sub-Saharan Africa

ABSTRACT

The taxonomic history of the Ricciaceae (1937–1995) is reviewed. Over the years many attempts have been made to subdivide and rearrange the taxa in this large and puzzling family, but consensus has still not been reached. Hepaticologists are therefore urged to undertake more revisions worldwide, using modern methods of investigation to aid them in, hopefully, coming to an eventual agreement in defining the limits of subgenera, sections, species and subspecies in the Ricciae. In addition, a classification of sub-Saharan Ricciaceae, partially based on informal groups, is herein proposed.

UITTREKSEL

'n Oorsig van die taksonomiese geskiedenis van die Ricciaceae (1937–1995) word gegee. Oor die jare heen is talle pogings aangewend om die taksons in hierdie groot en moeilike familie op te deel en te herrangskik, maar eenstemmigheid is nog nie bereik nie. Hepatikoë word aldus aangemoedig om verdere hersienings wêreldwyd te onderneem en om moderne ondersoekmetodes aan te wend, wat hopelik sal help om uiteindelik eenstemmigheid te bereik oor die omskrywing van subgenusse, seksies, spesies en subspesies in die Ricciae. Verder word 'n klassifikasie van die Ricciaceae van Afrika, suid van die Sahara, wat gedeeltelik op informele groepe gebaseer is, hier voorgestel.

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INTRODUCTION

Upon recently re-reading Duthie & Garside's (1937) excellent account of the taxonomic history of the Ricciaceae, which begins with John Ray (1696) and spans the next $\pm$ 240 years, I was once more struck by the many attempts to subdivide and rearrange the taxa in this large and puzzling family during that time.

This publication aims to cover in chronological order the most important regional studies of the Ricciaceae, that span the period between the survey by Duthie & Garside and the present.

It has now become accepted practice to recognize only two genera in the family, the monotypic *Ricciocarpos* and the species-rich *Riccia*. Both genera are characterized by the simplicity of the sporophytes, which are immersed in the thallus, and by the lack of elaters. The assimilation

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tissue in *Ricciocarpos* (formerly section *Hemiseuma*) contains tiered air chambers, whereas in *Riccia* it has either narrow air canals or rather wide, uniseriate air chambers. Other major differences between *Ricciocarpos* and *Riccia* are the following: *Ricciocarpos* is terrestrial or aquatic; in the latter the ventral scales are much elongated and pendant, with the margins serrate; single oil bodies are scattered throughout the cells of the scales and thallus; the antheridia and archegonia are in groups confined to the median groove of the thallus. Except for the *Riccia fluitans* complex, which is often aquatic and has small ventral scales that are never pendant, *Riccia* species are terrestrial and the scales are sometimes evanescent, but mostly reach to the thallus margins or extend above them; oil bodies are absent and the gametangia are not strictly confined to the median groove of the thallus.

Although there are intermediate forms with regard to the width of the air spaces in *Riccia*, the two groups classified here are generally recognized respectively as subgenus (rarely as section) *Riccia* (formerly *Lichenoides* or *Euriccia*) and as subgenus *Ricciella* (formerly, occasionally, as genus or as section). In the latter, two formal subdivisions have been recognized for a long time by the position of the capsule in the thallus and by the direction of liberation of the spores, i.e. the spores can be liberated dorsally (section *Spongodes* Nees) or ventrally (section *Ricciella* (A. Br.) Rchb.). Only informal subdivisions of subgenus *Riccia* have, however, been recognized until recently, as it was thought that not enough was known about several aspects of many species in this subgenus, that occurs worldwide, to make formal subdivisions.

OVERVIEW OF REGIONAL STUDIES

In the following overview diagnostic features are not cited verbatim from each author's text, but information is extracted from the description and keys and then combined in an abbreviated form more or less retaining the author's choice of words.

1. DUTHIE & GARSIDE (1937, 1939): South Africa

In 1937 Duthie & Garside published their detailed history of the group. Although they were aware of at least 11 species in the genus *Riccia* from the Stellenbosch Flats alone, they dealt with only five species in the section, then referred to as *Ricciella*.

1.1 Genus *Riccia*: upper photosynthetic zone in majority of species consisting of pillar-like vertical rows of cells separated by narrow air spaces, terminal cells of vertical rows usually larger and devoid of chlorophyll.

1.1.1 Section '*Ricciella*': upper zone consisting of air chambers, apparently strictly uniseriate and separated by plates of chlorophyll-containing cells; chambers roofed over by epidermis perforated by simple air pores which enlarge and later on cause the dorsal surface to become pitted; spores liberated from dorsal surface of thallus, but deeply imbedded and clearly visible from below; common, annual species.

R. plana Taylor (synonym of *R. crystallina* L.); *R. rautanenii* Steph. (synonym of *R. cavernosa* Hoffm. emend. Raddi). Spores separate at maturity; monoicous.

R. cupulifera A.V. Duthie. Spores separate at maturity; dioicous; heterothallic.

R. curtisii (James ex Austin) Austin (corrected author citation); *R. compacta* Garside (air chamber layer rather more compact and firmer). Spores retained in permanent tetrads; dioicous; heterothallic.

Nowadays species that retain their spores in permanent tetrads are assigned to subgenus *Thallocarpus* (Lindb.) Ast (1975).

Duthie & Garside suggest that the Ricciaceae may be a polyphyletic group, derived along several lines of descent. Their work together was discontinued when Duthie retired in 1939.

2. FRYE & CLARK (1937–1947): North America

Frye & Clark recognized three genera in the Ricciaceae, namely *Riccia*, *Ricciocarpus* (orth. var.) and *Oxymitra*.

2.1 Genus *Riccia*: thalli growing on damp or wet soil or suspended in water but not floating; air spaces narrow or chambered; antheridia and archegonia scattered; sporophyte without involucre; air pores inconspicuous, not stellate, the walls radiating from them not greatly thickened; divided into sections *Euriccia* and *Ricciella*.

2.1.1 Section *Euriccia*: air chambers are spaces between vertical or subvertical columns of photosynthetic cells; species assigned here are grouped together by absence or presence of cilia and by size of scales.

R. dictyospora Howe, *R. macallisteri* Howe, *R. bifurca* Hoffm.; *R. glauca* L., *R. sorocarpa* Bisch., *R. campbelliana* Howe, *R. nigrella* DC., *R. albida* Sull., *R. austinii* Steph. Margins of thallus without cilia; scales conspicuous or inconspicuous.

R. californica Austin, *R. hirta* (Austin) Underw., *R. beyrichiana* Hampe ex Lehm., *R. trichocarpa* Howe, *R. donnellii* Austin. Margins of thallus with cilia.

2.1.2 Section *Ricciella*: air chambers polyhedral hollows bounded by unistratose walls; margins of thallus lack cilia; ventral scales lacking or rudimentary.

R. membranacea Gottsche & Lindenb., *R. frostii* Austin, *R. crystallina* L. (misidentified and is *R. cavernosa*), *R. sullivantii* Austin. Mature spores not grouped in tetrads.

R. curtisii. Mature spores remaining attached in tetrads.
R. fluitans L. Thalli free-floating or stranded; segments narrowly linear.

In all modern treatments, two of the species they included in section *Ricciella*, *R. curtisii* and *R. membranacea*, are assigned to different subgenera, namely *Thallocarpus* (as mentioned before) and *Leptoriccia* (Schuster 1984) respectively.

2.2 Genus *Ricciocarpus* Corda: *R. natans* (L.) Corda. Thalli floating to stranded or rarely growing on very wet

soil; antheridia and archegonia located in median groove; dorsal surface distinctly reticulate on account of air chambers visible through it; monotypic.

2.3 Genus *Oxymitra* Bisch.: *O. androgyna* Howe. Thalli growing on soil, air chambers large, subvertical, prismatic or pyramidal; sporophyte with conspicuous conic or triangular-pyramidal involucre; pores stellate due to greatly thickened walls radiating from them.

Müller (1940) segregated the family Oxymitraceae from the family Ricciaceae, to accommodate the genus *Oxymitra* in the suborder Ricciineae. Although its sporophytes are similar to those of the Ricciaceae, its thalli and chromosome number are different, for which reasons it is best treated in a separate family. Garside (1958), however, described a new species of *Oxymitra*, *O. cristata*, from South Africa, but referred it to the family Ricciaceae and not to Müller's (1940) family Oxymitraceae, although he mentioned Müller's publication. This was presumably done because Garside was unsure whether the name *Oxymitra* would be upheld.

3. SCHUSTER (1949): central and western New York

In an early study on the Hepaticae of this region, Schuster treated *Ricciocarpus* and *Riccia* (with 6 local species) in the Ricciaceae.

3.1 Genus *Ricciocarpus* Corda: *R. natans*. Aquatic; occurring in circumneutral or somewhat calcareous waters, shallow and still or occasionally stranded on shore; thallus broad; ventral scales purple, dense, stiff, sword-like.

3.2 Genus *Riccia*: no subgenera or sections are mentioned, but the key distinguishes between the following two groups:

3.2a Group 1. *R. fluitans* (a mostly aquatic species), *R. crystallina*, *R. sullivanii* (the latter bracketed, because it only presumably occurs in the above area), *R. frostii*. 'Photosynthetic tissue loose, separated by more or less widely polyhedral air chambers, walls between chambers only one cell thick; ventral scales absent or obsolete.'

3.2b Group 2. *R. sorocarpa*, *R. arvensis* Austin (a synonym of *R. bifurca* Hoffm.). 'Photosynthetic tissue compact, with narrow vertical or subvertical, canal-like air chambers (at times becoming polyhedral near margins); spores areolate to alveolate, over 65 µm in longer diameter.'

4. SCHUSTER (1953): Minnesota and adjacent regions

Subsequently in reporting on the family Ricciaceae (Suborder Ricciineae) from Minnesota and adjacent regions, Schuster (1953) followed the conventional treatment of placing in it the genera *Ricciocarpus* and *Riccia*. In the latter he now recognized two subgenera, *Ricciella* and *Euriccia* (with two sections).

4.1 Genus *Ricciocarpus*: *R. natans*. Aquatic or subaquatic, floating on water surface or stranded; in imperfect, partial rosettes, with long, linear ventral scales; thallus with narrow, sharp, median groove, air pores and scattered oil cells.

4.2 Genus *Riccia*: thallose forms with sporophyte reduced and surrounded by thallus tissue; air pores vestigial and very inconspicuous, surrounded by hardly modified cells; terrestrial forms in rosettes, but some species normally aquatic; very variable.

4.2.1 Subgenus *Ricciella*: internal photosynthetic tissue loose, forming large, polyhedral chambers (i.e. not compact in structure in cross section); ventral scales rudimentary; marginal cilia of thallus lacking; dorsal surface of terrestrial forms often lacunose and spongy with age.

R. fluitans (with related European taxa, *R. rhenana* Lorb., *R. duplex* Lorb. and *R. canaliculata* Hoffm. not yet found in North America). Thallus segments narrowly linear, less than 0.7 mm wide; free-floating under water; sterile.

R. frostii, *R. crystallina* (misidentified and is *R. cavernosa*), *R. sullivanii* (the latter with sporangia bulging and rupturing ventrally). Thallus segments relatively broad, always terrestrial; spores various.

4.2.2 Subgenus *Euriccia*: photosynthetic tissue compact; spores always regularly areolate on external faces, with or without wing margin.

R. austini (sic), *R. dictyospora*, *R. macallisteri*, *R. sorocarpa*, *R. arvensis*. Thallus margins acute, sharp or rarely obtuse, without obvious cilia; scales large, hyaline or purple, protruding beyond thallus margins or not.

R. hirta, *R. beyrichiana*, *R. trichocarpa*. Thallus margins obtuse, never sharp, with distinct cilia.

4.2.2.1 Section *Hirtae*: *R. hirta*, *R. beyrichiana*, *R. arvensis*, and *R. eldeeniae* Jacobs (a synonym of *R. warnstorffii* Limpr. ex Warnst.). Defined as 'extreme xeric forms which may show cilia and development of purplish pigmentation of lateral thallus margins under extreme insolation'.

4.2.2.2 Section *Papillosae*: *R. atromarginata* Levier. Defined as 'extreme xeric forms abundantly hirsute'. No mention is made of the author(s) of the two sections, nor are there Latin descriptions or references that I could trace, so I must infer that possibly, Schuster himself was the author of these two sections which were, of course, then not validly published.

5. MEIJER (1951): The Netherlands

5.1 Genus *Riccia* is defined by Meijer as including land and water form species, frequently with ventral scales; the compact rosette-shaped thalli are less strongly forked in the land forms than in the water forms, which have thin, narrow lobes that branch regularly and frequently; chlorophyll-containing cells have smaller or larger air spaces between; in isolated species reduced air pores are present; two subgenera are recognized.

5.1.1 Subgenus *Euriccia*: chlorophyll-containing top portion of thallus with narrow air canals bounded by 4 cell pillars:

R. glauca. Thallus 4–5 times wider than thick in transverse section.

R. subbifurca Warnst. ex Crozals (with large scales), *R. bifurca*, *R. beyrichiana* (the latter two species with small scales), *R. sorocarpa* (distinguished by the second

dary epidermis having thickened walls). Thallus 1–3½ times wider than thick in tranverse section; thallus margins with few or no cilia.

5.1.2 Subgenus *Ricciella*: top portion of thallus contains large superimposed air chambers separated on all sides by unicellular walls; (they are said to have the ability to adopt an amphibian life style).

R. canaliculata (land form). Thallus ± twice wider than thick, not or seldom branching.

R. crystallina, *R. huebeneriana* Lindenb. Thallus in a rosette, spongy in older parts or with pitted appearance dorsally.

R. rhenana, *R. fluitans*. Thallus not in a rosette, dorsally not pitted.

Meijer remarked on the problems encountered in studying dried *Riccia* material and the desirability of examining living examples.

6. MÜLLER (1951–1958): Europe

Müller also recognized two genera, *Ricciocarpus* and *Riccia* in the family Ricciaceae.

6.1 Genus *Ricciocarpus*: *R. natans*. Thalli floating on water; with long, band-shaped ventral scales hanging down; can also manifest as a land form, when ventral scales are small; assimilation tissue with large, tiered air chambers, air pores present; oil bodies scattered in thallus and ventral scales; gametangia sunken along centre of thallus.

6.2 Genus *Riccia*: land forms or submerged in water; ventral scales small, rarely projecting above thallus margins; assimilation tissue in parallel cell rows or chambered; air pores sometimes present in subgenus *Ricciella*; oil cells lacking and gametangia scattered over whole surface of thallus.

6.2.1 Subgenus *Ricciella*: assimilation tissue consists of chambers; simple air pores are now and then present in roof over chambers.

R. frostii, *R. crystallina*, *R. crystallina* var. *angustior* Nees (= *R. cavernosa*), *R. huebeneriana*. Thalli in small or large rosettes; spores various.

R. fluitans, *R. canaliculata*, *R. rhenana*, *R. duplex*. Thalli linear, rarely forked; dorsally often clearly marked into areas; some mostly aquatic.

Müller attempted (rather like Stephani (1898) and others before him) to arrange the large number of species in the subgenus *Euriccia* into informal groups, the members of which are related by one or more shared characters, e.g. the presence of cilia along the thallus margins or by papillae on the dorsal surface or by thickened walls in the (sub)dorsal cells.

6.2.2 Subgenus *Euriccia*: assimilation tissue consists of cell rows, ending in a larger cell on top.

6.2.2a Group Ciliifera

R. ciliifera Link, *R. gougetiana* Mont., *R. gougetiana* var. *erinacea* Schiffn., *R. zachariae* Lorb., *R. sommieri*

Levier, *R. melitensis* C. Massal., *R. macrocarpa* Levier. Some thalli with single cilia, but not a very constant character.

6.2.2b Group Ciliata

R. ciliata Hoffm., var. *epilosa* Warnst. var. *intumescens* Bisch., var. *violacea* Kny, *R. canescens* Steph., *R. crozalsii* Levier, *R. michelii* Raddi, *R. bicarinata* Lindb. Thallus margins mostly with numerous long cilia.

6.2.2c Group Bifurca

R. bifurca, *R. beyrichiana*. Terminal branches with margins raised and swollen; median groove wide and shallow.

6.2.2d Group Sorocarpa

R. ligula Steph., *R. warnstorffii*, *R. sorocarpa* (subdorsal cells with thickened walls), var. *heegii* Schiffn., *R. breidleri* Jur., *R. oelandica* C.E.O. Jensen. Small plants, mostly linear or lingulate, rarely with a few cilia.

6.2.2e Group Papillosa

R. papillosa Moris. Dorsal surface and along margins with large papillae.

6.2.2f Group Nigrella

R. subbifurca, *R. nigrella*, *R. atomarginata* var. *glabra* Levier, *R. trabutiana* Steph. Thalli mostly in small rosettes; sometimes with deep median groove; occasionally with blunt papillae dorsally.

6.2.2g Group Lamellosa

R. lamellosa Raddi. Ventral scales large, hyaline and extending above thallus margins.

6.2.2h Group Glaucia

R. glauca var. *subinermis* (Lindb.) Warnst. Thalli thin; at margins occasionally with short hairs; in rosettes; scales colourless.

7. ARNELL (1956): Scandinavia

In his treatment of the 'Hepaticae of the Moss Flora of Fennoscandia', Arnell placed the family Ricciaceae in the suborder Ricciineae H. Buch and also recognized two genera, *Ricciocarpus* and *Riccia*.

7.1 Genus *Ricciocarpus*: *R. natans*. Floating form with long ventral scales hanging down, land form with smaller scales; cordate; leathery; greyish green to dark green; dorsally with pores surrounded by 5 or 6 thin-walled guard cells; assimilative tissue containing several large air chambers, one lying above the other; ventral tissue thin; oil cells present; antheridia in small groups sunken in the middle.

7.2 Genus *Riccia*: dorsal surface of thallus not leathery; yellowish to dark green; assimilative tissue consisting of vertical cell rows with interposed vertical, air-filled canals, or consisting of the walls of the air chambers, the upper of which each has a little pore in the middle of its roof; antheridia scattered or in groups, not crowded in special organs.

7.2.1 Subgenus *Euriccia*: assimilative tissue consists of vertical cell rows surrounding narrow vertical air canals.

R. cilifera (sic), *R. glauca*, *R. dalslandica* S.W. Arnell, *R. beyrichiana*, *R. bifurca*, *R. ciliata*, *R. warnstorffii*, *R. subbifurca*, *R. sorocarpa*. Thalli in rosettes or not; small or large; branches thick or thin; narrow or wide; margins winged or not, round or acute, naked or with cilia; epidermal cells rarely thick-walled.

7.2.2 Subgenus *Ricciella*: assimilative tissue consists of irregular chambers, separated by walls one cell thick.

R. canaliculata, *R. crystallina* var. *angustior* (= *R. cavernosa*), *R. rhenana*, *R. fluitans*, *R. duplex*, *R. frostii*, *R. huebeneriana*. Thalli linear, little-branched or repeatedly furcate, thick or thin, reticulate, occasionally aquatic, mostly terrestrial, sometimes in rosettes, large or small, dorsally pitted.

8. JONES (1957): tropical Africa

The usual two genera were recognized by Jones in The 'Ricciaceae in Tropical Africa'.

8.1 Genus *Ricciocarpus*: *R. natans*. Very widely distributed; floating in still water; with long pendant ventral scales.

8.2 Genus *Riccia*: subdivided into the subgenera *Ricciella* and *Euriccia*.

8.2.1 Subgenus *Ricciella* (A. Braun) Boulay *sensu lato*: assimilation tissue with air chambers (aquatic or terrestrial).

R. fluitans. Floating on water or growing on wet soil; branches elongated, parallel-sided, 0.5–1.0 mm wide; air chambers occupying most of thallus; spores rare.

R. membranacea. Branches many times broader than thick, tapering into thin wings; dorsally areolate, older parts becoming cavernous; air chambers large, occupying most of thallus, except for 2 or 3 layers of basal tissue in median part.

R. moenkemeyeri Steph. Branches tapering, apically sharply channelled; becoming pitted dorsally; scales distant, not reaching edge of thallus.

R. rautanenii (synonym of *R. cavernosa*). Large, spongy rosettes; margins of thallus thick.

R. intermedia E.W. Jones. Branches parallel-sided, apically sharply grooved; air chambers medianly narrow and inconspicuous, like in *Euriccia*, but wider toward the margins. *Riccia intermedia* was regarded by Jones as intermediate between *Ricciella* and *Euriccia* with respect to the width of the air chambers or air canals; it was later placed in synonymy under *R. discolor* Lehm. & Lindenberg by Pandé & Udar (1958) and classified in *Euriccia*.

Jones refers to Duthie & Garside's publications (1937; 1939) and stresses that *Ricciella sensu lato* contains several well-marked groups of species which are worthy of sectional, if not of subgeneric rank.

8.2.2 Subgenus *Euriccia*: assimilation tissue with closely packed filaments.

R. trichocarpa. Margins of thallus with long, hyaline cilia.

R. nigrosquamata E.W. Jones (= *R. berriei* E.W. Jones), *R. nigerica* E.W. Jones, *R. lanceolata* Steph., *R. radicata* Pearson, *R. rhodesiae* S.W. Arnell, *R. runsorensis* Steph., *R. congoana* Steph., *R. angolensis* Steph., *R. papillispora* Steph. (*R. albomarginata* Bisch. and *R. limbata* Bisch. are confined to the southwestern Cape). Margins of thallus without cilia, ventral scales extend to, or greatly exceed margins of thallus, distant or approximate or imbricate; hyaline or with hyaline margins or dark violet; thallus winged or not, when flanks steeply ascending; spores subglobose or tetrahedral.

The type specimen of *R. rhodesiae*, S.W. Arnell 1291 (S), is a mixed collection of *R. rhodesiae* and *R. atropurpurea* Sim, and Jones mistakenly identified the *R. atropurpurea* portion of the specimen as *R. rhodesiae*; *R. rhodesiae* and *R. nigrosquamata* were placed in synonymy under *R. congoana* by Perold (1986b).

9. PANDÉ & UDAR (1958): India

9.1 Genus *Riccia*: divided into subgenera *Euriccia* and *Ricciella*.

9.1.1 Subgenus *Euriccia*: thalli with compact assimilatory zone and narrow air spaces.

R. melanospora Kashyap. Thallus bluish green; segments small; anteriorly sulcate, rest nearly flat; cilia both on margins and on surface, small and broad.

R. warnstorffii. Thallus yellow-green; segments narrow, linear, apex rounded; deeply sulcate anteriorly and sulcus broader behind; cilia large.

R. crozalsii. Thallus bluish green; segments lanceolate; anteriorly deeply sulcate, rest very broadly channelled.

R. tuberculata Pandé & Udar. Thallus small, about 3 times broader than high; tubercular thickenings on cells of assimilatory filaments; spores irregularly reticulate or papillate, winged.

R. discolor. Male plants comparatively smaller than female; spore reticulate, unwinged.

R. billardieri Mont. & Nees. Thallus large, 4–6 times broader than high; spores reticulate, with prominent projections.

R. gangetica S. Ahmad. Thallus small, about three times broader than high; spores black, with 8–16 small reticulations across distal face.

9.1.2 Subgenus *Ricciella*: thalli with loosely arranged assimilatory zone and wider air spaces.

R. huebeneriana. Thalli narrow, repeatedly branched; spores small.

R. plana (synonym of *R. crystallina*). Thalli narrow, repeatedly branched; spores much larger.

R. frostii. Thalli forming well-defined rosettes, female rosette normally larger than male; spores incompletely reticulate.

Riccia cruciata is mentioned in the key, but there is no description of it.

10. HÄSSEL DE MENÉNDEZ (1963): Argentina

Hässel de Menéndez treated the Argentinian Ricciaceae.

10.1 Genus *Ricciocarpus*: *R. natans*. Plants floating or terrestrial; photosynthetic layer formed by several superimposed air chambers; ventral layer almost absent; scales in 3–5 series on both sides of midline.

10.2 Genus *Riccia*: plants terrestrial; photosynthetic layer formed by one layer of air spaces surrounded by walls of adjoining cells or by columns of chlorophyllose cells; ventral layer developed; scales in 1 or 2 series.

10.2.1 Subgenus *Ricciella*: photosynthetic tissue consisting of air chambers separated by walls one cell thick; pores surrounded by complete rings or not, cells similar to the others in dorsal walls of air chambers.

R. paranaensis Hässel, *R. stenophylla* Spruce. Thalli linear, capsules ventrally prominent as described by A. Braun.

R. membranacea, *R. crystallina* (misidentified and is *R. cavernosa*), *R. plana*, *R. frostii*, *R. paraguayensis* Spruce, *R. curtisii*. Thalli frequently in rosettes; capsules slightly or ventrally not prominent; spores separating at maturity except in *R. curtisii*, where they are united in tetrads.

10.2.2 Subgenus *Riccia*: photosynthetic tissue formed by chlorophyllose columns separated by narrow canals.

R. lindmanii Steph. Thallus margins without cilia.

R. bialbistrata Hässel. Thallus margins with cilia.

R. iodocheila Howe. Apex of thallus with some purple papillae.

R. austinii, *R. andina* Müll.Frib., *R. plano-biconvexa* Steph., *R. campbelliana*, *R. squamata* Nees, *R. fruchartii* Steph. Walls of dorsal cells not thickened.

R. sorocarpa, *R. dorsiverrucosa* Hässel. Walls of dorsal cells thickened.

No formal or informal groupings were made in either subgenus. *Riccia crystallina*, as treated by Hässel, is actually *R. cavernosa*, as the two species were frequently confused until Jovet-Ast (1964, 1966) cleared up the matter. Hässel selected *R. glauca* as the lectotype of the genus *Riccia*, because Howe's lectotype, *R. crystallina*, belongs in subgenus *Ricciella* and it is therefore contrary to previous practice.

The specimen, leg. *Sleumer 1755*, identified as *R. campbelliana* by Hässel, has large dark red scales, in contrast to those from other specimens of this species, in which they are inconspicuous, fragile and hyaline, splashed with brown and purple patches (Perold & Volk 1988a). Schuster (1992a) has assigned it to a new subspecies, *R. campbelliana* subsp. *austriгена*. *Riccia dorsiverrucosa* (as well as *R. andina* Müll.Frib.) were recently placed in synonymy under *R. manryana* Steph. by Jovet-Ast (1991).

11. ARNELL (1963): southern Africa

In his book *Hepaticae of South Africa*, Arnell (1963) recognized Müller's Oxymitraceae and the family Ricciaceae in the suborder Ricciineae. For the rest he followed the same classification here as in his earlier work (Arnell 1956) on Scandinavian Ricciaceae. He made no

attempt to arrange the species in the genus *Riccia* into sections or groups.

11.1 Genus *Ricciocarpus*: *R. natans*. Floating on water (with long, serrate scales) or growing on mud; dorsal surface leathery, reticulate, greyish green to dark green; air chambers large; pores present, surrounded by 5 or 6 thin-walled guard cells; ventral tissue thin; ventral face with several rows of purplish ventral scales, numerous and long in aquatic form; oil bodies in scales and thallus; antheridia in small groups, sunken in the midline of thallus; sporogonia rare, immersed in thallus.

11.2 Genus *Riccia*: most species only have land forms, but some species in subgenus *Ricciella* have both terrestrial and aquatic forms; dorsal surface of thallus not leathery; pores lacking except in some species of subgenus *Ricciella*; ventral scales generally small; green layer of assimilative tissue consists either of vertical cell pillars with interposed air-filled spaces or (consists) of walls of air chambers; oil bodies lacking; antheridia scattered or in groups, not crowded in special organs.

11.2.1 Subgenus *Euriccia*: assimilative tissue composed of cell pillars surrounded by air spaces.

R. canescens (synonym of *R. trichocarpa*), *R. crozalsii*. Margin of thallus with long cilia.

R. villosa Steph., *R. albomarginata* Bisch., *R. concava* Bisch. Margin of thallus usually without cilia; dorsally velvet-like by the presence of free cell pillars.

R. sorocarpa. Epidermal cells in 2 layers, second layer with thick walls.

R. coronata Sim, *R. natalensis* Sim. Epidermal cells with thin walls, some of them elongated and free.

R. atropurpurea, *R. limbata*, *R. angolensis*, *R. albolimbata* S.W. Arnell, *R. albosquamata* S.W. Arnell, *R. capensis* Steph., *R. rhodesiae*, *R. pottsiana* Sim, *R. warnstorffii* (an introduced species), *R. runssorensis*, *R. okahandjana* S.W. Arnell. Epidermal cells in one layer, not forming free pillars, but an adherent dorsal layer; scales absent or present, large or small, hyaline or purple to black.

11.2.2 Subgenus *Ricciella*: assimilative tissue composed of large air chambers with walls one cell thick.

R. fluitans, *R. stricta* A.V. Duthie ined. Thalli with long, linear segments, usually aquatic plants or rarely to frequently terrestrial.

R. purpurascens Lehm. Usually terrestrial, large plants; tuber formation on ventral stolons.

R. perssonii S.A. Kahn, *R. curtisii*, *R. spongosa* S.W. Arnell, *R. compacta*. Tetrads of spores permanently adherent, male plants much smaller than female ones.

R. cupulifera, *R. rautanenii*, *R. plana*, *R. crystallina*. Monoicous, except for *R. cupulifera* which is dioicous; spores separating when mature; plants in rosettes; male and female plants the same size or male plants slightly smaller.

R. bulbosa Steph. (Link ex Lindenb. is actually the author), *R. garsidei* Sim, *R. montaguensis* S.W. Arnell, *R. volkii* S.W. Arnell, *R. rubricollis* Garside & A.V. Duthie ined. Plants not forming complete rosettes, simple or dichotomously branched, very thick.

Arnell (1957) had previously described several new *Riccia* species based on collections made by Volk in Namibia, but had failed to recognize that the species with velvet-like dorsal surfaces (Arnell 1963) form a distinct group (later named section *Pilifer* O.H. Volk); *R. villosa*, *R. albomarginata* and *R. concava* belong together in this group and are quite distinct from ciliate species; no *R. coronata* Sim specimens could be traced; *R. capensis*, as interpreted by Arnell, was *R. nigrella*, whereas *R. capensis* Steph. is a synonym of *R. limbata* Bisch. (Perold & Volk 1988b); *R. albosquamata* was placed in synonymy under *R. albolimbata* (Perold 1989); *R. rhodesiae* is a synonym of *R. congoana* (Perold 1986b); *R. pseudolimbata* S.W. Arnell is a synonym of *R. angolensis*; *R. chrystallina* (sic) is *R. cavernosa* and *R. plana* is a synonym of *R. crystallina*; *R. montaguensis* is a synonym of *R. bullosa* (Perold 1991c); *R. spongosa* is a synonym of *R. curtisii* (Perold 1991a).

12. VANDEN BERGHEN (1972): Zaïre, Zambia

Vanden Berghen reported on the Ricciaceae of Zaïre's province Shaba and of Zambia. *Ricciocarpus natans* specimens were listed, as well as several *Riccia* species, but the latter were not assigned to any particular subgenus.

12.1 Genus *Ricciocarpus*: *R. natans*. Thallus with wide air cavities and small pores surrounded by 6–8 cells on the dorsal face; floating in water, with long violet scales, or when at water's edge, without long scales; oil bodies isolated in specialized cells; antheridia and archegonia surrounded by a rudimentary involucre in the median groove.

12.2 Genus *Riccia*: plants annual or perennial; terrestrial or aquatic; thallus dichotomously branched, frequently forming small rosettes; thalli with air cavities generally narrow; ventral scales mostly present, sometimes evanescent; without oil cells; antheridia and archegonia not surrounded by an involucre.

R. membranacea. Thalli very thin, 6–10(–15) times wider than thick; lobes 2.8–4.0 mm wide.

R. fluitans. Plants freely floating in water or stranded on mud; capsules strongly protruding on ventral face of thallus; lobes up to 1 mm wide; ventral scales absent or very reduced and evanescent.

R. cavernosa, *R. moenkneyeri*, *R. intermedia*, *R. symoensii* Vanden Berghen. Terrestrial plants; capsules not strongly protruding on ventral face of thallus; lobes generally 1–2 mm wide; ventral scales absent or very reduced, or large and violet.

As mentioned before, *R. intermedia* has been synonymised under *R. discolor*. It also appears, from Vanden Berghen's description and illustration of the spores of his so-called *R. fluitans*, that he was actually dealing with *R. stricta*.

13. JOVET-AST (1975): diverse areas

Twenty years ago Jovet-Ast studied the species *R. personii* and *R. curtisii*, which retain their spores in permanent tetrads. Previously, on account of the tetrad spores, Austin (1869) had placed *R. curtisii* in his new genus, *Cryptocarpus*, but Lindberg (1874) called attention to the

fact that the generic name, *Cryptocarpus*, was already in use and proposed the name *Thallocarpus*, instead. Subsequently, however, these plants were treated under subgenus *Ricciella*, until *Thallocarpus* was reinstated as an independent subgenus by Jovet-Ast (1975).

14. CAMPBELL (1975, 1977): New Zealand

14.1 Genus *Ricciocarpus*: *R. natans*. Plants in spongy, partial rosettes, up to 20 mm in diameter; when floating in ponds, little-branched and green or yellow-green in colour; dorsally firm and convex, with deep median furrow; upper epidermis interrupted by simple air pores; composed below of several series of large air chambers bounded by unistratose walls; ventrally with few rhizoids but with numerous conspicuous and characteristic pendant scales, toothed, ribbon-shaped and reddish violet or brownish green in colour; when temporarily stranded on shore, freely branched; with numerous smooth and tuberculate rhizoids; scales only rudimentary; rarely fertile in either aquatic or land form.

14.2 Genus *Riccia*: divided into two subgenera.

14.2.1 Subgenus *Riccia*: with a rather compact photosynthetic layer consisting of more or less vertical filaments separating narrow air chambers.

R. crozalsii. Margin of thallus with cilia, mainly near apex, 200–500 µm long.

R. ciliata. Cilia abundant along margin, 600–900 µm long.

R. sorocarpa. Dorsal groove deep and narrow.

R. bifurca, *R. glauca*. Dorsal groove shallow and wide.

14.2.2 Subgenus *Ricciella*: photosynthetic layer spongy and consisting of unistratose walls enclosing polyhedral air chambers.

R. fluitans. Thallus free-floating or stranded, not attached; segments narrowly linear.

R. crystallina. In glassy green or grey-green spongy rosettes; air chambers large and in several layers.

R. vesiculosa (Carrington & Pearson) Steph., formerly thought to be *R. bullosa* (pers. comm.), green or olive-green, strap-shaped and large; median air chambers narrow, those of the wings larger and in layers.

15. GROLLE (1976, 1983): Europe and adjacent regions

Grolle in his 'Lebermoose Europas' divided *Riccia*, as usual, into the subgenera *Riccia* and *Ricciella* (A. Br.) Boulay. In 1983 he stated the authors of the latter subgenus to be (A. Br.) Rchb., with *R. fluitans* as the newly selected lectotype. Two sections were recognized, namely *Ricciella* and *Spongodes* (the latter with the newly selected lectotype, *R. crystallina*). No attempt was made to arrange the species into groups, nor are diagnostic characters given.

16. NA-THALANG (1980): Australia

In her study of Australian Ricciaceae, Na-Thalang thought it incorrect for the two subgenera, *Riccia* and *Ricciella*,

to be separated on the size of the air chambers, because the characteristics of air chambers, pores and epidermal cells ought to be considered more important than the size of the air chambers.

16.1 Genus *Riccia*: monoicous or dioicous; complete or incomplete rosettes or in gregarious patches; mostly land forms; annual or perennial; upper surface normally sulcate; margins sometimes with cilia or scales of various sizes; dorsal part with compact tissue in vertical columns or with loosely arranged tissue forming polyhedral air chambers; capsules with neither seta nor foot, normally embedded in thallus.

16.1.1 Subgenus *Riccia*: upper part of thallus composed of compact tissue arranged in almost vertical columns; air chambers narrow, without specialized air pores; epidermal cells hyaline.

16.1.1.1 Section *Viridisquamata* Na-Thalang: *R. caroliniana* Na-Thalang. Dorsal part of thallus consists of compact, hyaline tissue; chlorophyll-bearing layer at ventral side of thallus, but almost whole thallus pellucid, destitute of chloroplasts except a few towards apex, margins and ventral layer next to scales; scales narrowly oblong, green, cells containing chloroplasts, imbricate and persistent, 1 or 2 layers of cells in thickness; branches furcate or bifurcate.

16.1.1.2 Section *Riccia*: chlorophyll-bearing layer at dorsal part of thallus; consists of compact vertical columns of green cells terminated by hyaline epidermal cells, each air space normally enclosed by 4 vertical columns; in some species, air chambers close to the margin may be enlarged, when surrounded by 5 or 6 columns.

Three groups are recognised.

16.1.1.2a Group Ciliatae: thalli bear cilia at margins and sometimes on dorsal surface.

16.1.1.2aa Subgroup Longiciliata: plants with long cilia on thallus and on capsule.

R. longiciliata Na-Thalang, *R. crinita* Taylor, *R. areolata* Na-Thalang. Closely related species, but with different spore characters.

Seppelt (1983) subsequently reduced Na-Thalang's *R. longiciliata* and *R. areolata* to synonyms of *R. crinita*. *Riccia longiciliata*, with $n = 16$, is regarded by him as only a polyploid of *R. crinita*, with $n = 8$, and it was concluded that the three species cannot be satisfactorily delimited by spore characteristics, neither can they be differentiated by morphological gametophyte characteristics.

16.1.1.2ab Subgroup Crozalsii: plants with short cilia on thallus, none borne on capsule.

R. crozalsii, *R. blackii* Na-Thalang, *R. asprella* Carrington & Pearson. Thalli small to larger; margins tumid and raised; channel broad.

16.1.1.2b Group Squamatae: thalli with scales reaching to or extending beyond margins.

16.1.1.2ba Subgroup Macrospora: thalli with variable purple scales; spores globose.

R. macrospora Steph., *R. gangetica*, *R. billardieri*, *R. discolor*. Colour of scales and thalli sensitive to environmental change.

16.1.1.2bb Subgroup Limbata: scales dark purple; spores triangular-globular, proximal face with triradiate mark.

R. limbata, *R. nigrella*. Colour of scales not easily changed.

16.1.1.2bc Subgroup Sorocarpa: scales hyaline; mostly annuals.

R. sorocarpa, *R. lamellosa*. Introduced species.

R. marginata Carrington & Pearson, *R. olgensis* Na-Thalang, *R. rorida* Na-Thalang. Australian species, probably endemic.

16.1.1.2c Group Laevigatae: scales small, only present under apex of thallus.

R. bifurca, *R. albida*. Introduced species; thallus margins rounded, the latter species being the only *Riccia* with smooth and rounded spores.

16.1.2 Subgenus *Ricciella*: upper part of thallus composed of rather loosely arranged chlorophyll-bearing tissue forming reticulate one-layered cell plates; air chambers polyhedral, normally roofed over by green epidermal cells with an air pore in the centre.

Two groups are recognized.

16.1.2a Group Terrestricae: land forms, sometimes growing on mud.

16.1.2aa Subgroup Crystallina: annual plants; in round and compact rosettes.

R. crystallina, *R. cavernosa*. Thalli not strap-like, broader than 1.5 mm; capsules not bulging markedly on ventral surface.

16.1.2ab Subgroup Papulosa: large thalli, 3–6 mm wide.

R. papulosa Steph., *R. spongiosula* Na-Thalang. Plants not strictly annual; forming rosettes only in young stages.

16.1.2ac Subgroup Vesiculosa: thalli smaller, 2–3(4) mm wide; hygrophilous plants.

R. vesiculosa (Carrington & Pearson) Steph., *R. muscicola* Steph., *R. deserticola* Steph., *R. crassa* Steph., *R. junghuhniana* Nees & Lindb., *R. collata* Na-Thalang. Scales mostly small and hyaline.

16.1.2b Group Aquaticae-Terrestricae: thalli narrow-linear or strap-like; multifurcate; capsules bulging on ventral surface.

R. luticola Na-Thalang, *R. duplex*, *R. multifida* Steph. Plants growing in water or on land; upper surface marked out by air chamber areas or not.

Na-Thalang's groups were not given formal taxonomic status, because she considered a worldwide appraisal of the genus a necessity before formalizing taxa below the

level of subgenus. Schuster (1992a), however, correctly points out that these informal groupings are 'nomenclaturally irrelevant'.

17. JOVET-AST (1984): Australia

Jovet-Ast raised Na-Thalang's (1980) section *Viridisquamata* (containing *R. caroliniana*) to subgeneric rank, because of the very unusual structure of its lobes, which could represent either a primitive stage, i.e. a relictual endemic of Australia, or else a parallel lineage to the genus *Riccia*. Its spores are, however, comparable to those of many other species of *Riccia*. Jovet-Ast, therefore, thought it preferable to maintain it in the genus *Riccia*.

17.1 Genus *Riccia*

17.1.1 Subgenus *Viridisquamata* (Na-Thalang) Ast: *R. caroliniana*. Dorsal part of thallus hyaline and compact; ventral part of thallus chlorophyll-bearing, i.e. layers inverted compared with other species of *Riccia*; ventral side of lobes with rows of chlorophyllous lamellae which are not scales; distal face of spores reticulate, forming 9 or 10 rounded areolae across diameter; proximal face similarly ornamented.

18. VOLK (1983): Namibia and southern Africa (and elsewhere)

In 1981 Volk described a new *Riccia* species, *R. albovestita*, from Namibia. It, and others like it, are characterized by a dorsal epithelium of loose, erect cell pillars, which Arnell (1963) had referred to as 'velvet-like', but had not segregated into a distinct group. This was subsequently done by Volk (1983), when he created his new section *Pilifer*. He also proposed a new classification for the genus *Riccia*, in an attempt to avoid the problems caused by intermediate forms with regard to the width of the air canals/air chambers. This classification was no longer to be based on the width of the air chambers, but rather on the number and size of the air pores in the dorsal epithelium/epidermis of the thallus.

18.1 Genus: *Riccia*

18.1.1 Subgenus A. *Riccia* (*Euriccia* auct.): outer dorsal layer consisting of an epithelium of hyaline cells; without sharply delimited air pores.

18.1.1.1 Section *Viridisquamata*: *R. caroliniana*. Chlorophyllous tissue limited to ventral side of thallus and scales.

18.1.1.2 Section *Riccia* [*Lichenoides* (Bisch.) Nees]: *R. glauca*, *R. sorocarpa*, *R. limbata*, *R. angolensis* etc. Chlorophyll mostly in dorsal tissues; ventral scales not green; top cells of epithelium close together.

18.1.1.3 Section *Pilifer* O.H. Volk: *R. villosa* Steph., *R. albovestita* O.H. Volk, *R. concava* Bisch. etc. Upper cells of epithelium free, hair-like pillars.

18.1.2 Subgenus B. *Spongodes* (Nees) O.H. Volk: outer dorsal layer consisting of an epidermis with chlorophyll and sharply delimited air pores.

18.1.2.1 Section *Thallocarpus*: *R. perssonii*, *R. curtisii*. Spores in permanent tetrads.

18.1.2.2 Section *Spongodes* Nees: *R. crystallina*, *R. cavernosa*, *R. volkii*. Ripe spores free; sporangia opening dorsally.

18.1.2.3 Section *Ricciella* (A. Braun, pro gen.) Bisch.: *R. fluitans*, *R. canaliculata*, *R. stricta* etc. Sporangia bulging and opening ventrally.

19. SCHUSTER (1984, 1985): diverse areas

Schuster proposed a new subgenus, *Leptoriccia*, for *R. membranacea*, as well as a third genus in the Ricciaceae, namely his monotypic *Pteroriccia* R.M. Schust. to accommodate *R. villosa* Steph.

19.1 Genus *Riccia*

19.1.1 Subgenus *Leptoriccia* R.M. Schust.: *R. membranacea*. Thallus very thin with vestigial ventral tissue; spores with numerous papillae, not arising from a reticulum.

19.2 Genus *Pteroriccia* R.M. Schust.: *R. villosa* Steph. Thallus with tall dorsal cell pillars and large erect, imbricate ventral scales, margins serrate.

On account of the above characters Schuster thought that *Pteroriccia* was at least as distinct from *Riccia* as the water form of the separate, unrelated genus, *Riccio-carpus*, which has long, trailing, ventral scales also with serrate margins.

20. PEROLD (1986): southern Africa

In response to Schuster's publication on *Pteroriccia* Perold (1986a) attempted to draw attention to O.H. Volk's section *Pilifer*, which was instituted for the reception of all the then (and later) known *Riccia* species with tall, loose dorsal cell pillars. She also pointed out that scale margins vary considerably in some species of *Riccia*, from crenate to serrate to having long, multicellular appendages in a then, as yet, undescribed species. The new genus instituted by Schuster was accordingly regarded as synonymous with *Riccia*.

21. SCHUSTER (1985): worldwide

Schuster (1985), however, had already reduced the status of his genus *Pteroriccia* (here regarded as a synonym of section *Pilifer* O.H. Volk) to that of subgenus *Pteroriccia* (R.M. Schust.) R.M. Schust. after restudying the *Pteroriccia* complex and finding that the ventral scale criterion, which had strikingly isolated his type species, did not hold for several other taxa in the same taxonomic unit. He also thought that *Pilifer* O.H. Volk was illegitimate, as he had assumed (incorrectly, however) that no type species had been designated, whereas Volk (1983) had indeed selected *R. albomarginata* as the type species of his section *Pilifer*. Schuster (1985) recognized six subgenera in the Ricciaceae.

21.1 Genus: *Riccia*

21.1.1 Subgenus *Spongodes* (Nees) O.H. Volk: dorsal epidermis distinct, complete, becoming lacunose, chlorophyllose, with pores; air chambers large, polyhedral; ventral tissue several cell layers thick.

21.1.2 Subgenus *Leptoriccia* R.M. Schust.: dorsal epidermis distinct, complete, becoming lacunose, chlorophyllose with pores; air chambers large, polyhedral; ventral tissue vestigial.

21.1.3 Subgenus *Thallocarpus* [Austin (sic)] Ast: spores coherent in permanent tetrads; plants unisexual, strikingly heterothallic with dwarf males.

21.1.4 Subgenus *Riccia*: epithelial tissues in mutually connate cell rows between which vertical air canals are distinct.

21.1.5 Subgenus *Pteroriccia* (R.M. Schust.) R.M. Schust.: epithelial tissues free-standing, independent multicellular uniseriate hairs, formed of elongated cells; ventral scales typically large, projecting beyond thallus margins.

21.1.6 Subgenus *Viridisquamata* (Na-Thalang) Ast: chloroplasts limited to ventral strata of thallus; ventral lamellae bistratose and chlorophyllose.

22. SCOTT (1985): southern Australia

22.1 Genus *Riccia*: thallus often distinctly coloured; wedge-shaped, usually wider than thick; bifurcating frequently and forming rosettes; ventral scales conspicuous or not; antheridia and archegonia sunken in pits along mid-line of thallus; sporophyte merely a 'bag of spores' also sunken in thallus; spores with elaborate sculpturing on surface which seems to be diagnostic of each species; divided into two subgenera which are $\pm$ distinct.

22.1.1 Subgenus *Riccia* (*sensu stricto*): upper layer of thallus firm, consisting of compact vertical pillars of cells, closely packed together and joined at the top, forming a firm, close tissue with narrow, vertical air slots and an even, homogeneous upper surface.

R. asprella, *R. crozalsii*, *R. crinita*. Thallus margins with hairs, fine or coarse, few or abundant, confined to apex or not.

R. limbata, *R. nigrella*. Medium-sized or small; bordered by black ventral scales.

R. sorocarpa, *R. cartilaginosa* Steph. Smallish or large; ventral scales hyaline and just reaching thallus margin.

R. bifurca. Upper surface broadly channelled.

R. lamellosa, *R. rorida*. Thalli rimmed by white scales, extending beyond margins.

R. albida. Upper surface narrowly grooved; chalky white with calcareous incrustation.

22.1.2 Subgenus *Ricciella*: upper layer of thallus spongy; loosely arranged chlorophyllous tissue, forming polyhedral or large and irregular air chambers, usually with defi-

nite air pores; epidermal cells with chloroplasts except around air pores.

R. crystallina, *R. cavernosa*. Plants in circular rosettes; upper epidermis granular or rough or cavernous even near apex.

R. vesiculosa, *R. spongiosula*, *R. papulosa*. Plants dorsally sometimes becoming cavernous in older parts or honeycombed, except at apex or only at base.

R. multifida, *R. duplex*. Thalli narrow, strap-like, less than 1.5 mm broad; thick or thin; with or without reticulation; grooved along midline or only at apex.

23. VOLK & PEROLD (1986a): South Africa

In 1986 Volk & Perold described a new species, *R. schelpei*, which is a very distinctive plant; it was assigned by them to the new monotypic subgenus *Chartacea* Perold, which is restricted to the winter rainfall region of the Western Cape.

23.1 Genus: *Riccia*

23.1.1 Subgenus *Chartacea*: *R. schelpei*. Thallus when dry, with papery texture, epidermis parchment-like with thick-walled hyaline cells; air pores surrounded by a ring of thin-walled, superimposed cells; spores reticulate-faveolate on distal face; proximal face with small shallow areolae, sprinkled with granules.

Later in the same year Volk & Perold (1986b) described another new species, *R. hirsuta*, which was placed in the new section *Micantes* O.H. Volk & Perold, subgenus *Spongodes* (Nees) O.H. Volk.

23.1.2 Subgenus: *Spongodes*

23.1.2.1 Section *Micantes*: *R. hirsuta*. Thallus dorsally densely covered with crowded multicellular, hairlike, hyaline shiny pillars; assimilation tissue with polyhedral air chambers; ventral scales triangular and apically split into cellular strands; spores single, ornamentation reticulate; spores with 3–5(6) large central areolae completely or incompletely subdivided, proximal face incompletely reticulate.

Unfortunately the description of *R. hirsuta* was based on two distinct, but rather similar species; fresh collections of *R. hirsuta* showed the assimilation tissue to have air canals and not polyhedral air chambers and hence to belong to section *Pilifer*, subgenus *Riccia*; section *Micantes* was accordingly rejected by Volk & Perold (1990).

24. JOVET-AST (1986): Mediterranean countries

Jovet-Ast's study of Mediterranean Ricciae was the culmination of the examination of several thousand specimens collected during 22 surveys around the Mediterranean Sea. Although only subgenus *Riccia* (with section *Riccia*) and subgenus *Ricciella* (with sections *Ricciella* and *Spongodes*) grow in the area treated, she listed five subgenera in her classification: *Riccia* (with sections *Riccia* and *Pilifer*), *Ricciella*, *Thallocarpus*, *Viridisquamata* and *Leptoriccia*. In her keys, of which there are several

to subgenus *Ricciella*, she referred to Grolle's lectotypification of section *Spongodes* Nees and of section *Ricciella*. No formal or informal groups or subgroups were recognized in section *Riccia*, and varieties based on small differences in size and colour were rejected.

24.1 Genus *Riccia*: thallus in the form of simple, linear lobes or ramified 1–4 times or in complete or partial rosettes; compact or spongiose; dorsal surface flat or with longitudinal median furrow; margins glabrous or bearing papillae or cilia; lateral surfaces with scales, small or large, colourless, or flecked with violet, orange, or dark violet or entirely dark violet.

24.1.1 Subgenus *Riccia*: thalli not spongiose, without air chambers; chlorophyllose tissue consisting of cells arranged in vertical rows, between them filiform aeration canals that open dorsally by minute openings; terrestrial species.

R. crustata Trab., *R. lamellosa*, *R. melitensis*, *R. sorocarpa*, *R. glauca*, *R. macrocarpa*, *R. sommieri*, *R. bifurca*, *R. subbifurca*, *R. warnstorffii*, *R. nigrella*, *R. trabutiana*. Thallus glabrous; upper surface white or not; scales various.

R. atromarginata, *R. papillosa*, *R. gougetiana*, *R. ciliifera*, *R. bicarinata*, *R. trichocarpa*, *R. ciliata*, *R. michelii*, *R. beyrichiana*, *R. crozalsii*, *R. ligula*. Thallus bearing cilia or papillae.

24.1.2 Subgenus *Ricciella*: thalli spongiose and with numerous large lacunae opening to exterior; or thallus not spongiose, air chambers opening dorsally via pores; surrounding cells arranged stoma-like; air chambers separated by mostly unicellular walls.

24.1.2.1 Section *Spongodes*: thallus spongiose; dorsal surface bearing large lacunae or both lacunae and pores; capsules not very prominent on upper surface of lobes, enclosed in thallus; terrestrial species.

R. crystallina, *R. cavernosa*. Monoicous; thallus in rosettes.

R. frostii. Dioicous; pronouncedly heterothallic with male thallus much smaller than female thallus.

24.1.2.2 Section *Ricciella*: thallus mostly not spongiose, generally with dorsal epidermis bearing pores surrounded by regularly arranged cells; capsules protuberant on ventral surface of thallus; terrestrial or aquatic species.

R. perennis Steph., *R. huebeneriana*, *R. fluitans*, *R. duplex*, *R. canaliculata*. Thallus with or without clear areolation on dorsal surface; in *R. canaliculata* ventral apex of lobes covered by white scale, in other species not.

25. DAMSHOLT & HALLINGBÄCK (1986): Fennoscandia

Also published in 1986 was Damsholt & Hallingbäck's report on the *Ricciae* of Fennoscandia, which contained beautiful coloured photoprints to illustrate the different colours of the thalli as well as outstanding drawings by the Danish artist, Annette Pagh. Since they were dealing

with local species, only two subgenera were recognized, neither were any sections separated in either of the subgenera.

25.1 Genus: *Riccia*

25.1.1 Subgenus *Ricciella*: thallus with air chambers in assimilation tissue; secondarily adapted to damp or fresh water environments since air pores are here used as a floating mechanism.

R. cavernosa, *R. huebeneriana*. Land plants; in partial or complete rosettes.

R. canaliculata, *R. fluitans*. The former species is terrestrial, whereas the latter is a land or a water plant; neither grows in rosettes.

25.1.2 Subgenus *Riccia*: thallus compact; assimilation tissue with closely spaced vertical cell rows; adapted to dry areas; upper surface of thallus closes up as the sides meet and so dehydration is prevented.

R. bifurca, *R. beyrichiana*, *R. sorocarpa*, *R. warnstorffii*, *R. subbifurca*, *R. gothica* Damsh. & Hallingb., *R. glauca*. Thallus margins often glabrous.

R. ciliata, *R. ciliifera*. Thallus margins mostly ciliate.

R. dalslandica is placed in synonymy under *R. ciliata* var. *epilosa*; *R. glauca* forma *colorata* S.W. Arnell is treated as a separate species, *R. gothica*, by the authors. Jovet-Ast (1994) expresses some doubt that Damsholt & Hallingbäck had indeed examined the true type specimen of *R. ciliata* and argues that they may have confounded *R. ciliata* and *R. trichocarpa*, since she had examined the types of both and found them to be different.

26. VOLK & PEROLD (1990): South Africa

Volk & Perold in correcting their initial error (Volk & Perold 1986b) now referred *R. hirsuta* to section *Pilifer*; *R. tomentosa*, the other element on which the original description of *R. hirsuta* had been partly based, was referred to subgenus *Thallocarpus*, section *Pannosae* (sect. nov.), since its spores (absent in the original collection) are retained in permanent tetrads. *Riccia tomentosa* and *R. hirsuta* share triangular ventral scales with apical filamentous strands and elongated dorsal cell pillars.

27. SMITH (1990): Britain and Ireland

Smith treated the liverworts of Britain and Ireland. He commented that there seemed to be no general agreement about the arrangement of species within the subgenus *Riccia*, since Grolle (1983) had arranged them in alphabetical order and the arrangements of Müller (1951–1958), Jovet-Ast (1986) and others differed. He chose to follow Jovet-Ast as hers was, at the time, the most recent authoritative account.

27.1 Genus *Ricciocarpus*: *R. natans*. Plants floating in base-rich or neutral ponds, ditches and canals or on mud of dried-out ponds; with conspicuous linear-lanceolate ventral scales (terrestrial forms with small scales); dorsal epidermis with small distinct pores and scattered oil cells.

27.2 Genus *Riccia*: plants terrestrial or, if aquatic, submerged; often winter ephemerals or annuals; ventral scales small to larger; pores lacking or, if present, vestigial and not surrounded by specialised cells; oil cells lacking.

27.2.1 Subgenus *Ricciella*: thallus with chambers; epidermis breaking down to form lacunae in older parts of thallus or not; margins without cilia.

27.2.1.1 Section *Spongodes*: plants terrestrial; dorsal epidermal cells in older parts of thallus breaking down to form lacunae, rendering thallus spongy in appearance; capsules embedded in thallus, not protruding strongly on ventral side.

R. cavernosa, *R. crystallina*, *R. huebeneriana*. Plants terrestrial; not strap-like; older parts spongy in appearance; capsules not protruding strongly on ventral side of thallus [except in *R. huebeneriana* (parenthesis mine)].

27.2.1.2 Section *Ricciella*: plants aquatic or terrestrial; epidermal cells on dorsal side of thallus not breaking down, older parts of thallus not spongy in appearance; capsules protruding very strongly on ventral side.

R. canaliculata, *R. fluitans*, *R. rhenana*. Thallus not channelled, except sometimes in older parts; not reticulate or often reticulate; capsules common or rare.

27.2.2 Subgenus *Riccia*: thalli never spongy in appearance; margins ciliate or not; dorsal epidermal cells frequently soon lost; chlorophyllose tissue composed of vertical columns with narrow air spaces, forming a compact layer of green cells.

R. crozalsii. Thallus lobes with ciliate margins, cilia curved over thallus when dry.

R. subbifurca, *R. glauca*, *R. bifurca*, *R. beyrichiana*. Thallus lobes with marginal cilia if growing under moist conditions; not inflexed over thallus when dry.

R. nigrella, *R. sorocarpa*. Thallus margins naked; subepidermal cells of thallus lobes thick-walled in *R. sorocarpa*.

28. VAN MELICK (1991): The Netherlands

Van Melick undertook a revision of 1 259 Dutch herbarium collections of *Riccia*. Earlier bryologists in the Netherlands evidently did not have a clear concept of many *Riccia* species as many specimens had been misidentified. Eleven species were retained by him and his classification also follows that of Jovet-Ast (1986), but he comments that there was no 'eenduidige opvatting over de taxonomische indeling van het genus *Riccia*'.

28.1 Genus *Riccia*: plants once to several times dichotomously furcate or in rosettes; dorsal surface of lobes smooth or with stomata-like pores or else with raised epidermal cells, otherwise with crater-like openings; ventral surface of lobes with rhizoids and scales, these laterally displaced with growth of thallus; on t.s. dorsally with wide air chambers enclosed by green walls or with compact, pallisade-like assimilation tissue; ventral tissue paren-

chyma-like, lacking oil cells; monoicous or dioicous; capsules sunken in thallus.

28.1.1 Subgenus *Riccia*: dorsal side of thallus not spongy, lacking network of small areas, but epidermis with hyaline, round or pear-shaped, generally ephemeral cells; margins without or with cilia; assimilation tissue dorsal, with compact, vertical cell rows, separated by narrow air canals; ventral $\frac{1}{2}$ – $\frac{2}{3}$ of thallus compact storage tissue.

R. crozalsii. Thallus lobes at margins with more than 20 cilia that arch over thallus when dry.

R. glauca, *R. beyrichiana*, *R. bifurca*, *R. warnstorffii*. Thallus lobes without or with fewer than 20 cilia at margins and not arched over thallus when dry.

R. subbifurca. Thalli scattered, rarely in rosettes.

R. sorocarpa. Thallus lobes with deep, sharp groove; upper epidermis 2-layered, subepidermis with thick-walled cells.

28.1.2 Subgenus *Ricciella*: dorsal side of thallus with obscure or clear network of small areas; epidermis unistratose, sometimes with stoma-like pores, sometimes lacunose; margins of thallus without cilia; assimilation layer composed of loose tissue with two or more irregular layers of large or small air chambers; storage tissue ventral $\pm \frac{1}{3}$ of thallus.

28.1.2.1 Section *Spongodes*: plants growing on soil; dorsal side of thallus, especially in the older parts, spongy, caused by openings in epidermis; capsules ventrally bulging or not.

R. cavernosa. Thalli light green to yellow-green, turning brown with age; lobes 1.0–2.5 mm wide; groove absent; capsules sunken into thallus or dorsally slightly bulging.

R. huebeneriana. Thalli bright green, mostly with rose to wine-red flecks; lobes 0.3–1.0 mm wide; grooved; capsules bulging ventrally.

28.1.2.2 Section *Ricciella*: plants growing on soil or floating in water; dorsal side of thallus not spongy; epidermis without openings; capsules bulging ventrally.

R. canaliculata. Thallus lobes narrower at tips; ventral scales 1.5–2.0 times wider than high, apical scale reflexed cap-like over dorsal side.

R. fluitans. Thallus lobes widening at tips; ventral scales 2–5 times wider than high, apical scale not reflexed cap-like over dorsal side; land form or water form.

Riccia duplex and *R. rhenana* were not accepted as good species, because of the lack of constant diagnostic characters to differentiate them from *R. canaliculata* and *R. fluitans* respectively.

29. VOLK & PEROLD; PEROLD & VOLK; PEROLD (1984–1991): southern Africa

The Ricciaceae of southern Africa continued to be studied by Volk (1979–1984), then by Volk & Perold or by Perold & Volk (1984–1990) and lately by Perold (1991). Several new species were described between them.

In her Ph.D. thesis, Perold (1991a) recognized the following taxa in the Ricciae: subgenus *Riccia*, with two sections, *Riccia* (which was divided into the informal groups, 'Ciliatae' and 'Squamatae') and *Pilifer*, for which Schuster's subgenus *Pteroriccia* had not been adopted, as the composition of the air canals is no different from those in *Riccia*; subgenus *Ricciella* which was also divided into two sections, *Spongodes* (with two groups, 'Crystallina' and 'Vesiculosa'), and *Ricciella*; to subgenus *Chartacea*, *R. schelpei* was assigned and to subgenus *Thallocarpus*, *R. curtisii*, *R. compacta* and *R. perssonii*; section *Paunosae* was elevated to subgenus *Pannosae* (Perold) Perold. (See Perold's proposed classification of sub-Saharan Ricciae on p. 227.)

30. JOVET-AST (1991, 1993): Latin America

Jovet-Ast, in the study of the Ricciae of Latin America, listed the five subgenera previously recognized by her (Jovet-Ast 1986): *Riccia*, *Viridisquamata*, *Ricciella*, *Thallocarpus*, *Leptoriccia* and added a sixth one, *Chartacea*. Only four of these are from the area treated in these works, namely *Riccia*, *Thallocarpus*, *Ricciella* and *Leptoriccia*. In the subgenus *Riccia*, section *Riccia*, she used Stephani's (1898) two units, the Ciliatae and the Inermes, but introduced a refinement by distinguishing a third one, the Papillatae, for species with papillose lobes. Her groups were not given a specified rank and are informal.

30.1 Genus *Riccia*: thalli compact or spongiose; dorsal surface flat or with longitudinal median furrow; margins glabrous, or bearing papillae or cilia; lateral surfaces with scales.

30.1.1 Subgenus *Riccia*: chlorophyllose tissue compact, consisting of cells arranged in vertical rows with narrow air spaces between; epidermal pores simple.

30.1.1.1 Papillatae: margins of thallus lobes with papillae.

R. atomarginata var. *atomarginata*. Margins of lobes obtuse, papillae on the margins and lateral surfaces, 60–210 µm long, smooth.

R. violacea Howe var. *violacea*, *R. violacea* var. *laevis* Ast. Papillae on margins and lateral surfaces of lobes 25–130 µm long, granular or smooth.

R. iodocheila. Margins of lobes acute; papillae rare.

30.1.1.2 Ciliatae: margins of lobes with cilia.

R. horrida Ast, *R. trichocarpa*, *R. subdepilata* Ast, *R. enyae* Ast, *R. cubensis* S.W. Arnell. Lobes mostly abundantly and densely ciliate to base.

R. brasiliensis Schifffn., *R. lindmanii*. Lobes with few, sparse cilia.

30.1.1.3 Inermes: thallus margins glabrous, lacking papillae or cilia.

30.1.1.3a Group 1: *R. albida*. Lobes calcified; spores almost smooth.

30.1.1.3b Group 2: *R. albopunctata* Ast, *R. campbelliana*. Lobes not calcified; with idioblasts.

30.1.1.3c Group 3: *R. nigrella*, *R. boliviensis* Ast, *R. squamata*. Lobes not calcified; lacking idioblasts; scales brilliantly black.

30.1.1.3d Group 4: *R. vitalii* Ast, *R. ridleyi* A.Gepp, *R. wainionis* Steph., *R. ekuanii* S.W. Arnell. Lobes not calcified; lacking idioblasts; scales hyaline or violet; cells with 2 thickened bands.

30.1.1.3e Group 5: lobes not calcified; lacking idioblasts; scales hyaline; cells without thickened bands.

30.1.1.3ea Subgroup 1: *R. mauryana*. Inferior walls of epidermal cells granulose.

30.1.1.3eb Subgroup 2: *R. sauguineisporis* Ast. Inferior walls of epidermal cells smooth; cells of dorsal tissue all with thick walls.

30.1.1.3ec Subgroup 3: *R. sorocarpa*, *R. erythrocarpa* Ast. Inferior walls of epidermal cells smooth; cells of dorsal tissue not all with thick walls.

30.1.1.3ed Subgroup 4: *R. lauellosa*, *R. viannae* Ast. Inferior walls of epidermal cells smooth; cells of dorsal tissue with thin walls; scales white, extending beyond margins of lobes.

30.1.1.3ee Subgroup 5: *R. ianthina* Ast, *R. subplana* Steph., *R. plauto-biconvexa*, *R. grandis* Nees, *R. australis* Steph., *R. taeniaeformis* Ast, *R. fruchartii*, *R. elliottii* Steph., *R. breutelii* Hampe ex Steph., *R. brittonii* Howe, *R. howellii* Howe. Inferior walls of epidermal cells smooth; cells of dorsal tissue with thin walls; scales hyaline or tinted with violet, not extending beyond margins of lobes.

30.1.2 Subgenus *Thallocarpus*: *R. curtisii*. Dorsal tissue with air chambers; dorsal epidermis with pores enclosed by cells, sometimes with lacunae; scales absent; spores fused in tetrad, surrounded by external layer of exine.

30.1.3 Subgenus *Leptoriccia*: *R. membranacea*. Thallus thin, one layer of lacunae and 2 or 3 layers of cells; scales present or reduced or absent; spores free at maturity, spherical, 40–67 µm in diameter, external layer of exine surrounding each spore; sporoderm ornamented with fine spinules.

30.1.4 Subgenus *Ricciella*: thallus thick, up to 15 layers of cells, spongy; spores tetrahedral, diameter greater than 65 µm; sporoderm ornamented with alveoli or tubercles.

30.1.4.1 Section *Spongodes*: thalli spongy, divided into wide lobes; capsules hardly projecting on the two surfaces of lobes; scales small or very reduced or absent.

R. crystallina, *R. cavernosa*. Thalli in rosettes, spongy, 10–35 mm in diameter.

30.1.4.2 Section *Ricciella*: thalli wide and deeply divided or in narrow strips; capsules projecting on ventral surface of lobes; scales small or rarely reaching edge of lobes.

R. frostii, *R. paraguayensis* Spruce. Dioicous; heterothallic; female plants in rosettes.

R. chiapasensis Ast, *R. dnssiana* Steph.; *R. geissleriana* Ast, *R. hegewaldiana* Ast. Monoicous; lobes 1.5–4.0 mm wide; grouped together.

R. jovet-astiae Vianna emend. Vianna, *R. crassifrons* Spruce, *R. bahiensis* Steph., *R. stenophylla*, *R. linicola* Ast, *R. paranaensis*. Lobes 0.3–1.5 mm wide.

31. SCHUSTER (1992): North America (and elsewhere)

Schuster (1992a) maintained that infrageneric classifications in the genus *Riccia* were still unresolved. He now adopted a multiple system with eight recognizable subgenera, although he conceded that his attempts at dividing them up into a series of complexes and sections were largely provisional, since he collected chiefly in North America and Europe. He thought that it was up to students residing in the other areas to test the validity of his proposed new sections, and that other sections from Australia and Africa would without doubt have to be recognized. He nevertheless instituted 10 new sections and formally provided them with Latin descriptions and designated type species.

31.1 Genus *Riccia*: plants usually small; closely prostrate, normally on soil, rarely aquatic; annual to perennial; in rosettes or hemirosettes, occasionally gregarious; segments generally with a longitudinal dorsal groove which disappears proximally; thallus structure either with distinct, persistent, rarely disintegrating epidermis with pores, overlying polyhedral air chambers or without a continuous, defined epidermis and aerenchyma with vertical canal-like air chambers; thallus margins naked or with papillae, cilia or setae; ventral scales often inconspicuous; oil bodies absent; antheridia and archegonia sunken into thallus; sporophyte consisting of spherical capsule containing spores.

31.1.1 Subgenus *Riccia*: thalli with photosynthetic tissue compact, arranged in closely contiguous vertical cell rows separated by slender vertical air canals; dorsal epithelial cells breaking down, the hypodermal layer persistent, regularly arranged; scales small to large; cilia or papillae often present; spore release dorsal; spores single.

31.1.1.1 Section *Riccia*: thallus margins blunt or rounded, naked or with short cilia (under 300 µm); lacking specialized oil cells; scales relatively small, usually colourless or vestigial, failing to reach thallus margins; sulcus weakly impressed, soon widening and disappearing posteriorly.

31.1.1.1a Subsection *Riccia*: thalli never calcified and chalk-white dorsally; nearly always forming rosettes; sporangia tending to bulge more on ventral side of thallus than on dorsal; spores polar, with clearly defined wing margins.

R. glauca, *R. hirta*, *R. tenella* Jacobs, *R. bifurca*, *R. warnstorffii*, *R. beyrichiana*, *R. californica*, *R. setigera* R.M. Schust. Monoicous; thalli ciliate or not.

R. ozarkiana McGregor. Dioicous; dorsal sulcus wide.

31.1.1.1b Subsection *Albidae* R.M. Schust.: dorsal surface of thallus calcified, chalk-white; pores open into canals bounded by 5–7 cell rows; deep dorsal groove not widening posteriorly.

R. albida (= ?*R. crustata*). Epithelial cells persistent, tumid or sometimes conoidally inflated, rough with secreted calcium carbonate. This subsection was previously a section in Schuster (1992a).

31.1.1.2 Section *Lamellosae* R.M. Schust.: plants always naked on dorsal surface and margins; epidermal cells usually ephemeral and collapsing to irregular remnants, not thick-walled; dorsal groove sharp and usually ± persistent; scales two-ranked, usually well developed.

R. lamellosa Raddi subsp. *lamellosa*, *R. lamellosa* subsp. *austini* R.M. Schust., *R. andina* Müll.Frib. subsp. *andina*, *R. andina* subsp. *clitoniophora* R.M. Schust., *R. albolimbata*. Ventral scales hyaline, whitish, projecting beyond thallus margins.

R. albolimbata is a southern African taxon which Schuster now also reports from North America.

Jovet-Ast (1994) found spores in the type specimen of *R. andina* and has concluded that it is synonymous with *R. manryana*, which Schuster has placed in another section, namely *Sorocarpae*.

R. macallisteri, *R. dictyospora*, *R. nigrella*, *R. campbelliana* Howe subsp. *campbelliana*, *R. campbelliana* subsp. *austriгена* R.M. Schust. Ventral scales not conspicuously projecting beyond moist thallus margins, usually pigmented.

31.1.1.3 Section *Sorocarpae* R.M. Schust.: monoicous; thalli light green; less compact than in section *Sommieri*; epithelial cells with thick bases; hypodermal cells firm; thallus margins lacking cilia; scales two-ranked and small; dorsal groove deep.

R. sorocarpa subsp. *sorocarpa*, *R. sorocarpa* subsp. *arctica* R.M. Schust., *R. sorocarpa* subsp. *erythrophora* R.M. Schust., *R. dorsiverrucosa*, *R. manryana*. Ventral scales small, obscure, not or hardly imbricate, colourless or castaneous.

In her experience, Jovet-Ast (1994) finds *R. sorocarpa* to be a stable species, although there are certain modifications in the colour of the lobes and scales, in the thickness of the epidermal cell walls and in the diameter of the spores and size of the wing. She states that she is inclined to reject Schuster's subspecies of *R. sorocarpa* as they are based on a very small number of specimens seen by him and that the rank of subspecies is too important to designate to such weak variations.

31.1.1.4 Section *Sommieri* R.M. Schust.: dioicous; thalli deep green, with vertical purple flanks; very compact and

thick; epidermal cells delicate and hypodermal ones strikingly thickened.

R. sommieri. Ventral scales large, imbricate, blackish purple.

31.1.1.5 Section *Atromarginatae* R.M. Schust.: thalli dull, bluish green and deep purple or purple-black laterally; with a tendency to develop both blunt papillae and hyaline sharp, rigid cilia mostly under 80 µm long; spores opaque, nonpolar.

R. atromarginata forma *atromarginata*, *R. atromarginata* forma *glabra* Levier ex Müll.Frib., *R. violacea* var. *violacea* Howe, *R. violacea* var. *iodocheila* (Howe) R.M. Schust., *R. violacea* var. *laevis* R.M. Schust. Ventral scale small, often rudimentary, black-purple; margins sometimes with papilliform cells.

This section evidently consists of highly problematical species, subspecies, varieties and formae that need to be clarified.

31.1.1.6 Section *Ciliiferae* R.M. Schust.: thalli robust; ventrally with large keel and at apices often forming tubers; margins winged, often ciliate; sulcus deep, soon disappearing; scales hyaline, whitish, semicircular.

R. ciliifera, *R. gougetiana*, *R. erinacea* Schiffn., *R. melitensis* (from Malta). Thallus surfaces and margins mostly eciliate or with cilia 100–325 µm long.

Jovet-Ast (1994) doubts whether *R. melitensis* is placed correctly in this section, since it lacks marginal cilia; she also prefers to treat *R. erinacea* as a variety of *R. gougetiana* namely var. *armatissima* Levier ex Müll.Frib., because all its characteristics resemble those of *R. gougetiana*, except for the abundance of bristles.

31.1.1.7 Section *Ciliatae* R.M. Schust.: plants copiously ciliate with tapered, sharp cilia, 300–1000 µm long; median sulcus sharp near apices, soon broadened and shallow; flanks swollen; scales small, hyaline to purplish.

R. ciliata subsp. *ciliata*, *R. ciliata* subsp. *canescens* (Steph.) R.M. Schust., *R. ciliata* subsp. *grisea* R.M. Schust., *R. ciliata* subsp. *trichocarpa* (Howe) R.M. Schust., *R. crinita*. Cilia very thick-walled along at least one side, up to 1150 µm long; flanks usually purplish to purplish black.

Jovet-Ast (1983) has shown that *R. canescens* Steph. is a synonym of *R. trichocarpa* and she finds it unacceptable (Jovet-Ast 1994) that *R. trichocarpa* can be considered a subspecies of *R. ciliata*.

31.1.1.8 Section *Bicarinatae* R.M. Schust.: *R. bicarinata*. Thalli at margins with groups of 2–3 basally connate, thick-walled, sharp, roughened cilia; flanks ascending, blunt at margins; dorsally with sulcus soon widening.

31.1.1.9 Section *Albosquamatae* R.M. Schust.: *R. albosquamata* S.W. Arnell. Thalli without cilia or papillae; ventral scales with regularly oriented, almost quadrate, very firm-walled cells.

Arnell (1957, 1963) had based his description of *R. albosquamata* on two white-scaled species (Perold 1989), *R. albolimbata* and another which was later named *R. argenteolimbata*, using characters from both. *R. albosquamata* is regarded as a synonym of *R. albolimbata*; Schuster did not include this new section *Albosquamatae* in his later treatment (Schuster 1992b).

31.1.2 Subgenus *Ricciella*: most species terricolous or sometimes aquatic; dorsal epidermis chlorophyllose, smooth or with age lacunose; pores present although sometimes vestigial; thallus margins always lacking cilia; air chambers large; ventral scales in a single median row, semilunate, or (if 2-ranked) much reduced; sporophytes releasing spores ventrally or dorsally.

31.1.2.1 Section *Ricciella*: segments narrow and lingulate to linear, under 0.8 mm wide; dorsal epidermis normally persistent, usually perceptibly areolate; pores not enlarging.

R. fluitans, *R. stenophylla*, *R. rhenana*, *R. canaliculata*, *R. duplex*, *R. huebeneriana* subsp. *huebeneriana*, *R. huebeneriana* subsp. *sullivantii* (Austin) R.M. Schust., *R. paranaensis*. Scales remaining in a single median row or soon splitting into 2 rows; capsules protruding ventrally; some species aquatic or land plants.

Schuster (1992b) places *R. perennis* in synonymy under *R. canaliculata*, as Müller (1953–1958) had done before him, but this is emphatically rejected by Jovet-Ast (1994) who states that they are so different in appearance that one can recognize them even with the naked eye.

31.1.2.2 Section *Cavernosae* R.M. Schust.: thalli in rosettes, fleshy and succulent; photosynthetic tissue loose, air chambers large, polyhedral; dorsal epidermis delicate; pores enlarging with age and thallus becoming lacunose.

R. cavernosa, *R. crystallina*. Ventral scales apparently lacking or small and ephemeral.

Schuster (1992a) remarks that his section *Cavernosae* is perhaps identical with Nees's *Spongodes* but he finds the latter ambiguous because it includes both *R. bullosa* and *R. crystallina*. Whether *R. bullosa* remains in section *Spongodes* is not mentioned. Perold (1991a) referred *R. bullosa* to section *Spongodes*, group 'Vesiculosa'.

Schuster (1992b) notes that the prior usage of *R. crystallina* (for *R. cavernosa* sensu Jovet-Ast 1964; 1966) and *R. plana* (for *R. crystallina* sensu Jovet-Ast) was adopted by all workers and should have been preserved by pertinent lectotypification. *Riccia crystallina* has been lectotypified by Perold (1992) with the typotype held at FI and shows that Jovet-Ast was correct after all.

31.1.2.3 Section *Frostii* R.M. Schust.: *R. frostii*. Growing in rosettes; heterothallic with small male plants; photosynthetic tissue relatively compact with air chambers narrow and tall; scales lacking or vestigial; spores dorsally released.

31.1.3 Subgenus *Leptoriccia*: *R. membranacea*. Thalli delicate, exceedingly flat and thin, chiefly consisting of

epidermis and air chambers; ventral tissue vestigial; scales seemingly absent; sporangia ventrally protruding, spores single, spherical, apolar, covered in spines.

31.1.4 Subgenus *Thallocarpus*: dorsal epidermis chlorophyllose, with pores, becoming lacunose; thalli spongy, soft-textured; strongly heterothallic with much smaller male plants; assimilation tissue with large and high air chambers in 1–3 layers; spore release dorsal; spores in tetrads; rhizoids mostly smooth or in part conspicuously tuberculate.

31.1.4.1 Section *Thallocarpus*: thalli with dorsal surface smooth; ventral scales lacking or vestigial; spores of tetrad separated by distinct, $\pm$ smooth connecting band; spore surface with spine-like tubercles.

R. curtisii, *R. leptothallus* R.M. Schust., *R. howei* R.M. Schust. Plants forming rosettes or irregularly gregarious, with or without colour dimorphism in the sexes.

31.1.4.2 Section *Chaetoricia* R.M. Schust.: *R. tomentosa*. Distinct from sect. *Thallocarpus* in (a) thalli dorsally shaggy-haired, with long free-standing filaments formed of elongated cells; (b) ventral scales conspicuous, hyaline, triangular, apices bearing filaments formed of several cells; (c) spore tetrads only obscurely tetrahedral, very closely armed with papillae.

Riccia tomentosa was placed in subgenus *Thallocarpus*, section *Pannosae* by Volk & Perold (1990) and *Pannosae* was later elevated to the rank of subgenus (Perold 1991), but these must have escaped Schuster's notice, when he created the new section *Chaetoricia* for *R. tomentosa*.

31.1.5 Subgenus *Chartacea*: *R. schelpei*. Dorsal epidermis firm, thick-walled, echlorophyllose; pores conspicuous, surrounded by 5 or 6 small, thin-walled cells elevated above epidermal cells; thallus grooved, margins acute; gametangia limited to groove; spores single.

31.1.6 Subgenus *Micantes*: *R. hirsuta*. Dorsal epidermis densely invested with tapered ciliform (1)2–7-celled 'hairs'; pores obscure; ventral scales large, 2-ranked, shaggy; spores (95)115–125(130) μ m in diameter.

As pointed out above, the original description of *R. hirsuta* was based on two distinct, but superficially rather similar species, *R. hirsuta* (section *Pilifer*) and *R. tomentosa* (subgenus *Thallocarpus*, section *Pannosae*, (Volk & Perold 1990)). It is regrettable that the initial mistake by Volk & Perold was perpetuated by Schuster (1992a, b).

31.1.7 Subgenus *Pteroricia*: epithelial cells in the form of free-standing, independent multicellular uniseriate and often tapered hairs, mostly formed of elongated cells; distal cells of epithelial filaments persistent, typically smaller, often conoidal and/or conspicuously elongated.

R. villosa, *R. parvo-areolata* O.H. Volk & Perold. Mostly with large ventral scales projecting beyond thallus margins.

31.1.8 Subgenus *Viridisquamata*: *R. caroliniana*. Dorsal tissues devoid of chlorophyll, which is almost wholly limited to ventral strata of thallus; ventral surface with bi-stratose chlorophyllose transverse lamellae in V-shaped configurations, these giving rise to reduced unistratose ventral scales.

31.2 Genus *Ricciocarpus*: *R. natans*. Plants floating, occasionally terrestrial; dorsal surface with distinct pores surrounded by 5 or 6 cells; air chambers large and conspicuous; ventral scales linear, numerous, sword-like; oil bodies present; antheridia sunken in thallus or along median groove.

DISCUSSION

The above treatment has resulted in numerous species being assigned to different sections and groups in the works by Jovet-Ast (1991, 1993), and Schuster (1992a, b). One is also faced with the anomalous situation, that in two articles in the same publication, following directly on one another (Perold 1993; Fischer 1993), the same taxon, *R. vulcanicola* Eb. Fisch., is placed in two different sections, since Perold followed the time-honoured tradition of placing *R. crystallina* (and its allies, in this case *R. vulcanicola*) in section *Spongodes* Nees, whereas Fischer chose to follow Schuster (1992a, b), and placed it in section *Cavernosae*.

Anyone is, of course, free to follow the treatment of their choice, but for later students, it could be very confusing. However laudable the motive for arranging the large number of *Riccia* species into a series of more or less natural complexes or sections, so that they can be more easily 'digested', six of the 11 new sections proposed by Schuster (1992a) in the genus *Riccia* have only one species and four of the subgenera also only have one representative each. So, are we really making progress or are we just proliferating the number of higher ranking taxa, some of which may not stand the test of time? It calls to mind a remark attributed to the late Prof. Tom Harris of Reading University, 'You can always make any genus (or subgenus for that matter) uniform merely by making it monospecific, and thereby defeating the object of classification'.

It is as well to bear in mind Hässel de Menéndez's (1976) cautionary advice, 'since the nomenclatural system does not allow us to abandon completely names which are no longer required, continuing in this way will only result in the accumulation of too many names, each of which will be protected by the Code'.

Until more revisions worldwide have been completed, using methods such as biochemical and DNA analysis, enzyme electrophoresis, multivariate analysis, TEM studies of the ultrastructure of the spore wall, like that of Thaithong (1982), and cultivation experiments, it may be wiser to use informal groups. Once sufficient data have been gathered hepaticologists should come to an agreement in defining the limits of subgenera, sections, species and subspecies in the Ricciae.

I am not well acquainted with the Ricciae of North America, Latin America, the Mediterranean and Australia, but for sub-Saharan Africa, I propose the following classification, which is quite similar to that of Perold (1991), which, being in a thesis, is not widely known or available. As yet, only informal groups are recognized; see also Perold (1995): *A survey of the Ricciaceae of tropical Africa*.

32. PEROLD (1995): sub-Saharan Africa

32.1 Genus *Ricciocarpos*: *R. natans*. Thalli floating or terricolous; assimilation tissue with large air chambers in several tiers; scales long, pendant, purple ribbons, small in land form, margins dentate; oil cells present; gametangia along deep central groove; monotypic.

32.2 Genus *Riccia*: thalli mostly terricolous; assimilation tissue either compact, with cell columns enclosing narrow vertical air canals, or spongy, with air chambers; scales small to large, imbricate, mostly rounded, margins smooth, rarely denticulate; oil cells absent; gametangia along groove or scattered; polytypic.

32.2.1 Subgenus *Riccia*: thallus dorsally with an epithelium of mostly thin-walled cells, echlorophyllose, uni- or bistratose or bearing free-standing cell pillars; air pores numerous, generally small, regular, intercellular spaces; assimilation tissue compact; thallus margins naked or bearing cilia or mammillate cells; spores single.

32.2.1.1 Section *Riccia*: epithelium uni- or bistratose.

32.2.1.1a Group Ciliatae: *R. trichocarpa*, *R. crozalsii*, *R. microciliata* O.H. Volk & Perold, *R. natalensis*. Epithelium unistratose; thallus margins ciliated.

32.2.1.1b Group Mammillatae: *R. mammiifera* O.H. Volk & Perold. Epithelium unistratose; thallus margins, especially at the apex, with a row of mammillate cells.

32.2.1.1c Group Squamatae:

R. sorocarpa, *R. atropurpurea*, *R. lanceolata*, *R. nigerica*. Epithelium uni- or bistratose, generally with some cell walls thickened; thallus margins glabrous; scales not conspicuous.

R. congoana, *R. nigrella*, *R. limbata*, *R. angolensis*, *R. okahandjana*. Epithelial cells without thickened walls; thallus margins glabrous; scales large, dark, black or reddish black, to violet.

R. macrocarpa. Scales brown with violet blotches; idioblasts present throughout thallus. Sérgio (1991) has placed *R. campbelliana* in synonymy under *R. macrocarpa*.

R. pottsiana, *R. runssorensis*, *R. rosea* O.H. Volk & Perold, *R. radicata*, *R. erubescens* Perold. Scales pink to red; idioblasts absent.

R. albolimbata, *R. alborporosa* Perold, *R. albornata* O.H. Volk & Perold, *R. argenteolimbata* O.H. Volk & Perold, *R. bicolorata* Perold, *R. lanellata*, *R. montana* Perold, *R. saharensis* Steph. ex Ast, *R. somaliensis* Perold. Scales predominantly white or hyaline, often encrusted with calcium deposits.

32.2.1.1d Group Intermediatae: *R. discolor*, *R. synoensis*. Assimilation tissue medianly compact, air spaces widening toward wings.

32.2.1.2 Section *Pilifer*: epithelium in free-standing 2–5(6)-celled, uniseriate pillars, top cells variously shaped, soon collapsing, not regularly orientated; scales small to large, rounded and smooth at margins, rarely triangular and dentate or apically filiform.

R. alatospora O.H. Volk & Perold, *R. albomarginata* Bisch., *R. albovestita*, *R. ampullacea* Perold, *R. concava* Bisch., *R. elongata* Perold, *R. furfuracea* Perold, *R. hantamensis* Perold, *R. parvo-areolata*, *R. pulveracea* Perold, *R. simii* Perold, *R. trachyglossum* Perold, *R. vitrea* Perold. Scales rounded, margins smooth.

R. hirsuta. Scales triangular, apices split into several loose cellular strands.

R. villosa. Scales triangular, margins dentate.

32.2.2 Subgenus *Ricciella*: thalli dorsally with an epidermis of thin-walled, generally chlorophyllose cells; air pores mostly delimited, well spaced, fewer, often becoing lacunose; assimilation tissue spongy with polyhedral air chambers enclosed by unistratose cell plates; scales mostly hyaline or violet and inconspicuous, distant, often evanescent; sporangia deeply imbedded or bulging somewhat above or below; spores single.

32.2.2.1 Section *Spongodes*: thalli in rosettes; spongy.

32.2.2.1a Group Crystallina: *R. crystallina*, *R. cavernosa*, *R. vulcanicola* Eb. Fisch., *R. moenkemeyeri*, *R. huebeneriana*. Monoicous; spores completely or incompletely reticulate.

32.2.2.1b Group Cupuliferae: *R. cupulifera*, *R. frostii*. Dioicous; heterothallic with smaller male plants; spores foveolate or with vermiculate ridges.

32.2.2.1c Group Vesiculosa: *R. bullosa*, *R. garsidei*, *R. volkii*, *R. rubricollis*. Thalli rarely in rosettes, swollen to somewhat flatter, usually becoming cavernous; dorsally deeply grooved along entire length of branch or only apically; scales small, two-ranked.

32.2.2.2 Section *Ricciella*: plants terricolous or aquatic; thalli not in rosettes; branches linear, strap-shaped or 'ribbon'-like; not cavernous; scales ventral, one-ranked.

R. stricta, *R. purpurascens*. Sporangia bulging conspicuously ventrally.

32.2.3 Subgenus *Leptoriccia*: *R. membranacea*. Thalli thin and flat, ventral tissue vestigial; scales reduced or absent; spores spherical, small, ornamented with fine spinules.

32.2.4 Subgenus *Thallocarpus*: thalli in complete or incomplete rosettes; heterothallic; spores remaining in tetrads.

R. curtisii. Spores joined together by narrow band or ridge into tetrahedral tetrads; ornamentation with slender spicules up to 5 µm long.

R. perssonii. Spores joined by wide band into rhomboidal tetrads; ornamentation with stout spines 10–15 µm long.

32.2.5 Subgenus *Chartacea*: *R. schelpei*. Dorsal epidermis with thick-walled cells, lacking chlorophyll; air pores surrounded by superimposed ring of smaller, thin-walled cells; thallus narrowly grooved; acutely winged; scales rounded, persistent, large, reaching thallus margins; spores single.

32.2.6 Subgenus *Pannosae*: *R. tomentosa*. Dorsal epidermis with cellular outgrowths of very tall, hair-like outgrowths; air pores surrounded by radially arranged wedge-shaped cells; thallus broadly grooved; obtusely winged; scales triangular, persistent, large, filamentous apices extending beyond thallus margins; spores remaining in globular tetrads.

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Notes on African plants

VARIOUS AUTHORS

BORAGINACEAE

TYPIFICATION OF THE SECTIONS IN *LOBOSTEMON*

Levyns (1934) subdivided *Lobostemon* Lehm. into five sections without typifying them. According to Art. 10.1 of the ICBN (Greuter *et al.* 1994), any subdivision of a genus must be typified. For purposes of designation or citation of a type, the species name alone suffices. Furthermore, Art. 10.2 of the ICBN (Greuter *et al.* 1994) states that if no type of a previously or simultaneously published species name was included in the protologue of the subdivision, a type must be otherwise chosen.

Lobostemon Lehm. is typified by *L. echioides* Lehm. This species is placed in Levyns' (1934) section *Echioides*. Art. 22.1 of the ICBN (Greuter *et al.* 1994) stipulates that the name of any subdivision of a genus that includes the type of the adopted, legitimate name of the genus to which it is assigned is to repeat that generic name unaltered as its epithet.

Therefore, Levyns' (1934) *Lobostemon* section *Echioides* should be *Lobostemon* section *Lobostemon*, typified by *L. echioides* Lehm.; *Lobostemon* section *Argentei* Levyns should be typified by *L. argenteus* (Berg.) Buek.; *Lobostemon* section *Trichotomi* Levyns by *L. trichotomus* (Thunb.) DC.; and *Lobostemon* section *Fruticosi* Levyns by *L. fruticosus* (L.) Buek.

Buys & Van der Walt (1994) established *L. regulareflorus* (Ker Gawl.) M.H. Buys as the correct name for *L. grandiflorus* (Andr.) Levyns; therefore *Lobostemon* section *Grandiflori* Levyns is typified by *L. regulareflorus* (Ker Gawl.) M.H. Buys.

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PODOCARPACEAE

NOTES ON *PODOCARPUS* IN SOUTHERN AFRICA AND MADAGASCAR

In a recent reconsideration of the taxonomic status of various genera of Coniferae in the Podocarpaceae, Page (1988) elevated *Podocarpus* sect. *Afrocarpus* J. Buchholz & N.E. Gray to generic rank. Following the interpretation of Page (1988), *Afrocarpus* (J. Buchholz & N.E. Gray) C.N. Page is a small genus discontinuously distributed from equatorial Africa (Zaire, Ethiopia and Uganda) southward to south and southeast Africa and the Cape Province of South Africa. This group of tall, evergreen trees has been variously included at sectional level in the genera *Decussocarpus* de Laub. and *Nageia* Gaertn. by de Laubenfels (1969, 1987). Of the species of *Podocarpus* L' Hér. ex Pers. transferred to *Afrocarpus* by Page (1988) only one, *A. falcatus* (Thunb.) C.N. Page, the national tree of South Africa, occurs in southern Africa (Figure 1). The other species of *Afrocarpus* have a more northerly distribution. *P. latifolius* (Thunb.) R. Br. ex Mirb., *P. elongatus* (Aiton) L'Hér. ex Pers. and *P. henkelii* Stapf ex Dallim. & A.B. Jacks. were retained in *Podocarpus*.

In this contribution the infrageneric taxonomy of African and Madagascan *Podocarpus* is discussed with special reference to the new genus *Afrocarpus*. It is argued

that the reproductive morphological variability encountered in *Podocarpus* could best be accommodated at infrageneric level and that little purpose would be served by elevating *Podocarpus* sect. *Afrocarpus* to generic rank (Leistner 1966, 1988, 1991; Von Breitenbach 1991).

TAXONOMIC CONSIDERATIONS

Podocarpus L'Hér. ex Pers. *sens. lat.* is represented in Africa and Madagascar by three groups of species which can be briefly characterized as follows:

Group 1 (section *Podocarpus sensu* de Laub. 1985)

Female cones with 1 or 2 fertile scales fused with the cone axis to form a swollen, fleshy, often brightly coloured receptacle or podocarpium when mature. This receptacle is borne on a thin, naked stalk (Figure 2A, B). The leaves are mostly hypostomatic and have 3 or 5 resin canals. Representatives: *P. latifolius* (Thunb.) R. Br. ex Mirb. (synonym: *P. milanjianus* Rendle), *P. elongatus* (Aiton) L'Hér. ex Pers.

Group 2 (section *Scytopodium* de Laub. 1985)

Female cones with 1 fertile scale fused with the cone axis to form a clavate, glaucous, leathery receptacle not always clearly demarcated from its short, stout, naked stalk (Figure 2C). Leaves always hypostomatic and with 5 resin canals. Representatives: *P. henkelii* Stapf ex Dalim. & A.B. Jacks. (synonym: *P. ensiculus* Melville), *P. madagascariensis* Baker.

Group 3 (section *Afrocarpus* J. Buchholz & N.E. Gray 1948)

Female cones with 1 fertile scale fused with the cone axis into a very slightly swollen woody receptacle at the apex of a stout, scaly to leafy stalk (Figure 2D). The leaves are amphistomatic and have only 1 resin canal. Representatives: *P. falcatus* (Thunb.) R. Br. ex Mirb. (synonyms: *P. gracilior* Pilg., *P. gracillimus* Pilg., *P. gausseii* Woltz), *P. mannii* Hook. f. (synonyms: *P. usambarensis* Pilg., *P. dawei* Stapf).

A comparison of the listed characters shows that there are few differences between groups 1 and 2 but that group 3 differs in several characters from both 1 and 2.

How should the differences between the three groups be reflected in a taxonomic system? We consider the differences between groups 1 and 2 to be satisfactorily reflected by placing them in separate sections of the same genus. We therefore accept the scheme proposed by de Laubenfels (1985) who retained groups 1 and 2 in *Podocarpus* and placed group 1 in section *Podocarpus* and group 2 in section *Scytocarpus* de Laub. Page (1988, 1990) does not take account of group 2. In his key to the genera of Podocarpaceae (Page 1990) group 2 runs to *Afrocarpus* (J. Buchholz & N.E. Gray) C.N. Page but it does not match his description of that genus. It does, however, fit his description of *Podocarpus* except for the receptacle of the female cone which he describes as conspicuous, multiscaled and becoming swollen and fleshy and often highly coloured at maturity.

Although the differences between groups 1 and 2 on the one hand and group 3 on the other are considered more basic than those between groups 1 and 2, these differences are regarded as insufficient for separating them at either subgenus or genus level. As Page (1988) points out, botanists principally concerned with African trees or vegetation, such as Lind & Morrison (1974), Coates Palgrave (1977) and Hilliard (1985) have not recognized the



FIGURE 1.—Distinctive growth form of *Podocarpus falcatus*. The Big Tree near Knysna, southern Cape, as it appeared in 1938. Photo: N. Glen.

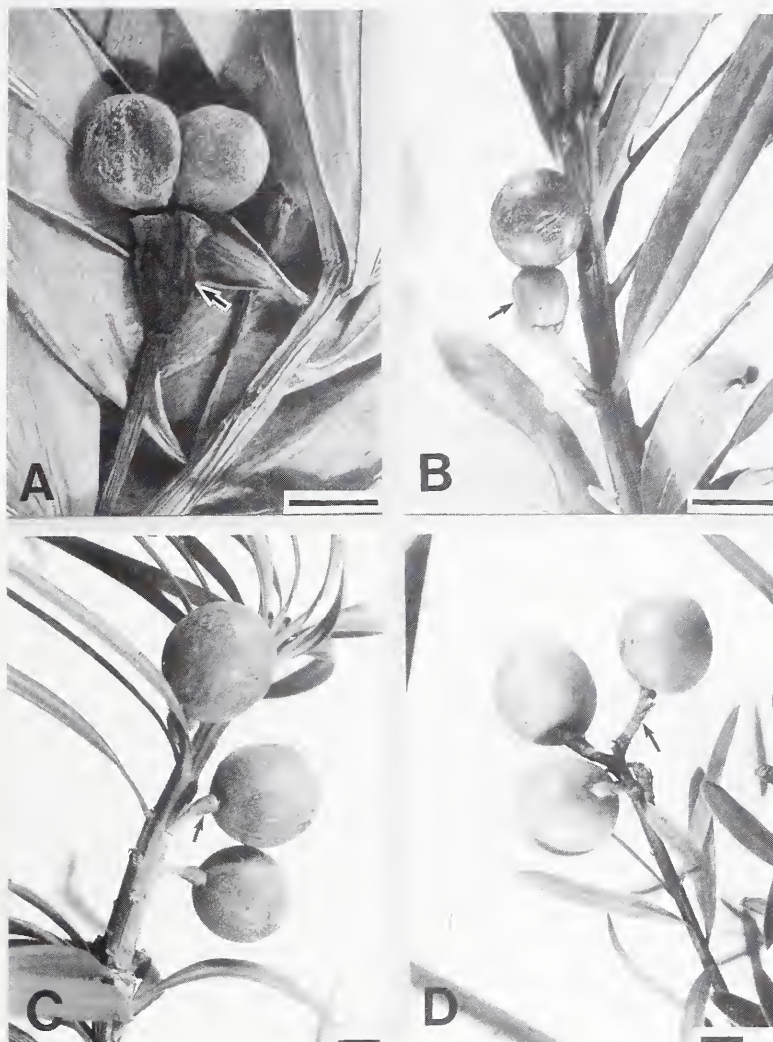


FIGURE 2.—*Podocarpus*, portion of branch with seed. A, B, showing collapsed but distinctly swollen receptacle (arrowed). A, *P. latifolius*, H. P. van der Schijff 5446 (PRE), collected in December 1960 at Nganduli near Koffiebaai in the Transkei; B, *P. elongatus*, fresh material collected in Kirstenbosch National Botanical Garden; C, *P. henkelii*, showing clavate leathery receptacle (arrowed); D, *P. falcatus*, showing woody receptacle at apex of stout, scaly stalk. C, D, fresh material collected in Pretoria National Botanical Garden. Scale bars: 7.5 mm.

splitting off of group 3 from *Podocarpus*. One reason for this attitude, Page (1988) speculates, may be the similarity in general tree form and vegetative appearance of the African members of *Podocarpus sens. lat.* He also mentions that the species of his genus *Afrocarpus* (group 3) are in some respects intermediate in taxonomic position between the African members of *Podocarpus sens. str.* and certain Asian genera. Group 2 (section *Scytodopodium*) which extends the circumscription of *Podocarpus* beyond the description given by Page (1990), further narrows the gap between group 3 on the one hand and groups 1 and 2 on the other, at least in respect of the female cones.

This note is based on a very limited number of characters. However, until a thorough investigation into generic relationships within the Podocarpaceae shows that our conclusions are not acceptable, we support the view that group 3 is still best accommodated as a section within *Podocarpus*.

The correct name of South Africa's national tree remains, therefore, *Podocarpus falcatus* Thunb. (Eng. Outeniqua Yel-

lowwood, Afr. Outeniekwageelhout; National List of Indigenous Trees No. 16; Von Breitenbach 1990).

Finally, mention should be made of the fact that Page (1988) has assigned the incorrect gender to *Afrocarpus* when making the combination of the type species, *A. falcata* (Thunb.) C.N. Page. He has given the specific epithet a feminine ending in spite of Article 62.2, Example 2 of the *International Code of Botanical Nomenclature* (Greuter *et al.* 1994) which states quite clearly that 'all modern generic compounds ending in the Greek masculine *-carpos* (or *-carpus*) are masculine'. Under *Afrocarpus* the specific epithet should therefore be *falcatus*.

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PTERIDOPHYTES

NEW DISTRIBUTION RECORDS OF SOUTH AFRICAN PTERIDOPHYTES

This note updates the last fern floras for southern Africa (Schelpe & Anthony 1986; Burrows 1990) by recording some recent collections which extend currently known distributions.

OPHIOGLOSSACEAE

1. *Ophioglossum gracillimum* Welw. ex Hook. & Baker, *Synopsis filicum*: 445 (1868); J.E.Burrows: 40 (1990); J.E.Burrows: 153 (1992); J.E.Burrows & T.J.Edwards: 186 (1993). Type: Angola, Pungo Andongo, near Catete, *Welwitsch* 36 (BM, lecto!; K!, LISU, iso.).

This very small, and consequently undercollected, fern was found growing in mixed *Acacia* woodland on the margins of a seepage zone together with *Ophioglossum luso-africanum* Welw. ex Prantl and *Isoetes welwitschii* A.Braun ex Kuhn at an altitude of 1 260 m. This taxon was previously placed in synonymy with *O. lancifolium* Presl (Schelpe 1970) but has recently been recognized as distinct (Burrows & Edwards 1993). This collection, however, represents the first record of *O. gracillimum* from South Africa (Figure 3). It was previously recorded from northern Zimbabwe and northwards through tropical Africa.

NORTHERN TRANSVAAL.—2329 (Pietersburg): Blood River, 8.8 km NW of Pietersburg, (—CD), J.E.Burrows & Venter 5224 (NU, PRE).

2. *Ophioglossum rubellum* Welw. ex A.Braun in Kuhn, *Filices africanae*: 179 (1868); Hook. & Baker: 445 (1868); J.E.Burrows: 205 (1992); J.E.Burrows & T.J.Edwards: 189 (1993). Type: Angola, Pungo Andongo, next to streams near Catete, *Welwitsch* 33 (K, lecto!; BM!, LISU, iso.).

Like the previous species, *O. rubellum* has probably been overlooked due to its extremely small size. Where it has been collected in Zimbabwe, it has been misidentified as *O. gomezianum* Welw. ex A. Braun (Schelpe 1970; Jacobsen

1983). However, the distinctive orange or reddish pigmentation of the plant, particularly on the stipes and spikes, make it quite distinct from *O. gomezianum*.

The two South African records were collected on shallow, seasonally wet soils overlying sheetrock. The Treur River collection was made in grassland near a river on quartzites, while the Nelspruit collection was made on granite in semi-deciduous woodland (Figure 3). In both localities three or more other species of *Ophioglossum* occurred.

EASTERN TRANSVAAL.—2430 (Pilgrim's Rest): Bourke's Luck, Goedgeloof Plantations, Treur River, (—DB), J.E.Burrows 5112 (K, PRE). 2531 (Komatipoort): Nelspruit, Nelsville, W of John Vorster Ave., (—AC), J.E.Burrows 5228 (PRE).

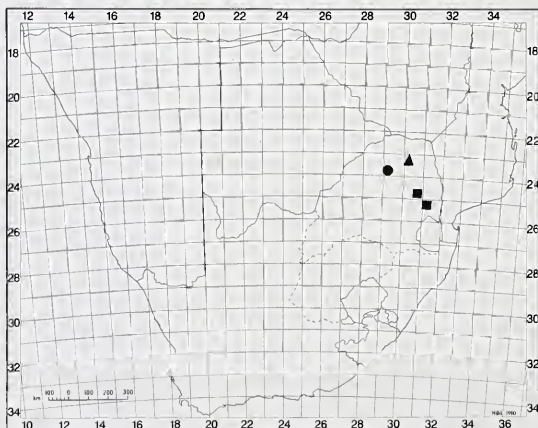


FIGURE 3.—Distribution of *Ophioglossum gracillimum*, ●; *O. rubellum*, ■; and *Asplenium obscurum*, ▲, in southern Africa.

PTERIDACEAE

3. *Pteris catoptera* Kunze var. *horridula* Schelpe in Boletim da Sociedade Broteriana, Ser. 2a, 41: 216 (1967); Schelpe: 118 (1970); W.Jacobsen: 241 (1983); J.E.Burrows: 164 (1990). Type: Zimbabwe, Untali [Mutare] District, Inyamatshira Range, Chase 4890 (BOL, holo.; BM, SRGH!, iso.).

Pteris catoptera var. *catoptera* is considered one of the most common forest floor ferns occurring in evergreen forests along the eastern escarpment of southern Africa (Burrows 1990). In contrast, the finely prickly variety *P. catoptera* var. *horridula* is apparently much less common. Until recently, the only record of this taxon from South Africa was a single collection from the Lydenburg District of the Eastern Transvaal (J.E.Burrows 3101).

In Natal, a population of var. *horridula* has been observed growing together with the typical variety in forest at the base of Sterkspruit Falls. This site, which is adjacent to the Mpofane River at an elevation of 1 450 m, is at the foot of the Natal Drakensberg escarpment (Figure 4).

Members of this population displayed considerable variation in the frequency of spinules on the rachises and stipes, a character consistent with the original description (Schelpe 1967). Specimens were found growing as understorey geophytes (sensu Jacobsen 1983) in forest litter on the damp forest floor, within 5 m of the Mpofane River. It would appear that var. *horridula* is more altitudinally restricted than var. *catoptera*, which has been collected at elevations ranging from sea level to 1 900 m (Schelpe & Anthony 1986). Although the Natal collection represents a considerable southerly extension of the taxon, it is envisaged that further collecting will result in the closing of the gaps between the rather disjunct records extending from eastern Zimbabwe to Natal.

KWAZULU-NATAL.—2929 (Underberg): Sterkspruit Falls at head of Waterfall Bush, Mpofane River, (–AB), Crouch 661 (NH).

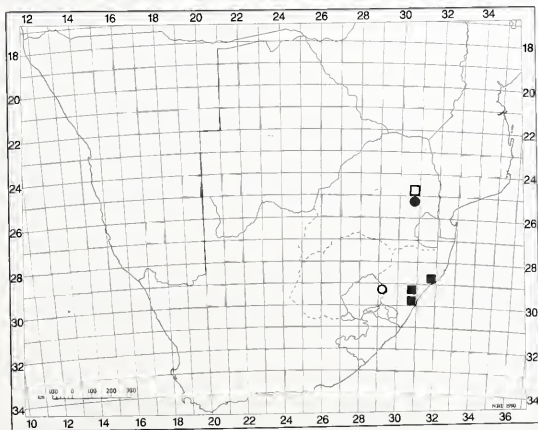


FIGURE 4.—Distribution of *Pteris catoptera* var. *horridula*, ● (new record, ○); and *Arthropteris monocarpa*, ■ (new record, □) in southern Africa.

OLEANDRACEAE

4. *Arthropteris monocarpa* (Cordem.) C.Chr. in Catalogue des Plantes de Madagascar, Pteridophyta: 32 (1932); Schelpe: 163 (1970); W.Jacobsen: 324 (1983); J.E.Burrows: 207 (1990). Type: Réunion, Boivin 881 (P, holo.).

The previously known distribution of this species was disjunct with records from central Natal and eastern Zimbabwe but with none from the region in between (Schelpe & Anthony 1986; Burrows 1990). It has now been found growing at the base of the eastern escarpment in the Mapulaneng Nature Reserve south of Mariepskop in the Eastern Transvaal, which effectively closes this gap. The plants were found growing over moss-covered boulders next to a mountain stream in evergreen forest at an altitude of 860 m (Figure 4). It occurs in association with *Thelypteris pulchra* (Bory de Willd.) Schelpe which was previously only known from a single record from South Africa, roughly 20 km to the north on the lower slopes of Mariepskop.

EASTERN TRANSVAAL.—2430 (Vaalhoek): Mapulaneng Nature Reserve, 3.3 km NNW (straight line) of Welgevonden, (–DB), 860 m, J.E.Burrows & S.M.Burrows 5238 (PRE).

ASPLENIACEAE

5. *Asplenium obscurum* Blume, Enumeratio plantarum Javae et insularum adjacientium: 181 (1828); Schelpe: 174 (1970); J.E.Burrows: 221 (1990). Type: Indonesia, Java, Burangrang Mountains (type not located).

During a collecting trip to the Soutpansberg in the Northern Transvaal, a small colony of *Asplenium obscurum* was discovered. This is the first record of this Afro-Pacific species for South Africa (Jacobsen 1983; Schelpe & Anthony 1986; Burrows 1990). The species has a mainly Asiatic distribution and in this region it has been recorded from Indonesia and the Philippines (Jacobsen 1983). It also occurs sporadically in the moist highlands of Zimbabwe and Mozambique, and in a few localities in Malawi, Tanzania and Madagascar.

In the Soutpansberg, *A. obscurum* was found growing between boulders in a rocky streambed in the deep shade of evergreen forest. The colony was located 5 m from the source of a perennial spring in association with *Tectaria gemmifera* (Fée) Alston and *Thelypteris madagascariensis* (Fée) Schelpe (Figure 3). This habitat is consistent with that noted for this sciophytic species from further north (Jacobsen 1983; Burrows 1990).

NORTHERN PROVINCE (TRANSVAAL).—2330 (Tzaneen): Hilldale Farm, spring source for homestead, (–AA), Crouch 640 (NU).

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CYPERACEAE

NEW RECORDS FOR SOUTHERN AFRICA AND KWAZULU-NATAL

INTRODUCTION

Three species of Cyperaceae, previously not known from the *Flora of southern Africa* (FSA) region (Retief 1993) are here recorded from that region and two species of the same family, previously not known from KwaZulu-Natal (Retief 1993), are newly recorded from that province.

Species new to the *Flora of southern Africa* region

1. *Eleocharis mutata* (L.) Roem. & Schult., *Systema vegetabilium* (Caroli a Linné) 2: 155 (1817).

This species has been recorded from West tropical Africa (Hooper 1972), East Africa (Haines & Lye 1983) and South America (Svenson 1929). It is the type species of *Eleocharis* subgen. *Limnochloa* (P. Beauv. ex Lestib.) C.B. Clarke sect. *Limnochloa* (P. Beauv. ex Lestib.) Benth.

It was recently collected by C.J. Ward and others at Lake Nhlabane, south of St Lucia Estuary (28°35'S; 32°15'E). Plants were growing within an extensive stand of *Eleocharis dulcis* (Burm.f.) Henschel. *E. acutangula* (Roxb.) Schult. was also present, but in shallower water towards the lake margin.

Specimens examined (Note: all numbers cited are deposited in K, NH, NU, PRE, UDW, except that C.J. Ward & A. Rajh 11464 is not at K.)

KWAZULU-NATAL.—2832 (Mtubatuba): Lake Nhlabane, S of St Lucia estuary, (–CB); *E. mutata*: C.J. Ward & A. Rajh 11600; C.J. Ward & G.W. Begg 11715, 11717. *E. dulcis*: C.J. Ward & A. Rajh 11459, 11464, 11597. *E. acutangula*: C.J. Ward & G.W. Begg 11378.

2. *Eleocharis decoriglumis* Berhaut in *Bulletin de la Société, Botanique de France* 100: 174 (1953).

This decorative species, worthy of cultivation in water features, has been recorded from West Africa (Hooper 1972; Vanden Berghen 1988) and from East Africa

(Uganda and Tanzania), where it is reported as 'very rare' (Haines & Lye 1983). It is described as an annual, unlike its two close relatives *E. acutangula* and *E. variegata*, both of which are stoloniferous perennials, but which lack the striking green and black glume colour contrasts of *E. decoriglumis*. A recent survey of exsiccata has revealed two specimens of *E. decoriglumis* from the same locality in Botswana. These collections were made by different workers and there is an interval of three months between their gatherings.

Specimens examined (Note: these specimens had previously been named *E. variegata* and *Eleocharis* sp., compare to *E. acutangula* respectively.)

BOTSWANA.—2023 (Kwebe Hills): Boteti River relict floodplain below Samedupe Bridge, 20.06°75'S; 23.31°6'E, P.A. Smith 1900 (PRE, SRGH); R.P. Ellis 2980 (PRE).

3. *Pycnus muricatus* (Kük.) Napper in *Journal of the East African Natural History Society* 28, No. 124: 6 (1971).

This species may be confused with *P. unioides* (R.Br.) C.B. Clarke, which is pantropic in distribution; in Africa it is well known and widespread. *P. muricatus* differs from this better known relative in developing stolons and in its more markedly sculptured (muricate-zonate) achene. In *P. unioides* the short rhizome that links the shoots is non-permanent and may be lacking; the achene surface is nearly smooth with faintly marked longitudinal cells that wear away.

Plants of *P. muricatus* were growing in abundance at Graskop. The species is also known from Lydenburg.

Specimens examined

NORTHERN PROVINCE (TRANSSVAAL).—2430 (Pilgrims Rest): Graskop, (–DD), J. Browning 653 (BOL, GENT, K, NU, PRE), 658 (NU).

EASTERN TRANSSVAAL.—2530 (Lydenburg): Onverwacht 733JT Game Trust, (–DD), J. Browning 504 (NU).

Species new to the flora of KwaZulu-Natal

1. *Eleocharis variegata* (Poir.) C. Presl in Oken, *Isis* 21: 269 (1828).

This variable species has a wide, but scattered tropical distribution (Hooper 1972). In the FSA area it is reported only from Botswana (Retief 1993). Plants are more slender and shorter than most other representatives of subgen. *Linnochloa*, but in general morphology relate to those of *E. acutangula* and *E. mutata*. There is variability in culm structure from terete, to trigonous and quadrangular and sometimes twisted, which range of form is not known for *E. acutangula* or *E. mutata*. There are also differences in floral glumes, achenes and perianth bristles that will not be detailed here.

Plants are here reported from two localities in Natal, where they were growing either in association with *E. acutangula* (in the Howick area) or with *E. mutata* and *E. acutangula* (Lake Nhlabane).

Specimens examined

KWAZULU-NATAL.—2832 (Mtubatuba): Lake Nhlabane, S of St Lucia Estuary, (—CB); *E. variegata*: C.J. Ward & G.W. Begg 11716 (K, NH, NU, PRE, UDW). *E. acutangula*: C.J. Ward & G.W. Begg 11378 (K, NH, NU, PRE, UDW). 2930 (Pietermaritzburg): Howick area, Gartmore Farm, 29°21'S, 30°16'E, (—AC); *E. variegata*: P.B. Taylor 132 (NU). *E. acutangula*: P.B. Taylor 131 (NU).

2. *Scleria unguiculata* E.A. Rob. in Kew Bulletin 18: 536 (1966).

This species has previously been reported for Togo, East Africa (Tanzania), Central African Republic and Zambia (Haines & Lye 1983). In southern Africa it is known only from Botswana (Franklin Hennessy 1985; Retief 1993).

It is here reported for KwaZulu-Natal. Slender plants were growing in acid bog (sedge meadow), the culms partially supported by associated vegetation. Growing in the

same microhabitat were plants of *S. achtenii* De Wild., which has obovoid to subglobose, white-haired achenes in contrast to the ovoid-ellipsoid, fulvous-haired achenes of *S. unguiculata*. This record is the first for the Republic of South Africa and increases by $\pm 10^\circ$ S latitude, the known distributional area of the species.

Specimens examined

KWAZULU-NATAL.—2832 (Mtubatuba): Lake Nhlabane, S of St Lucia Estuary, (—CB), C.J. Ward & A. Rajh 11611 (NU, PRE, UDW).

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LUNULARIACEAE

FRUITING *LUNULARIA CRUCIATA*, NOW ALSO REPORTED FROM SOUTHERN AFRICA

Sexual reproduction in *Lunularia cruciata* (L.) DuRoi. ex Lindb. occurs only rarely or sporadically. In an earlier article on *Lunularia cruciata* (Perold 1993), I did not describe mature archegoniophores with sporophytes, because no examples were available at PRE for study. In an attempt to raise them in cultivation, male plants collected in a nursery in Krugersdorp, west of Johannesburg (*Koekemoer 1004*) and female plants from Harold Porter National Botanical Garden, Betty's Bay (*Perold et al. 3029*), were planted together in September 1993 on soil in a pot and kept in a secluded courtyard. Although growing well and watered regularly, fertilization did not take place.

Recently, in late spring, on 8 November 1994, I received live material with androecial discs (Figure 5A) and archegoniophores in various stages of maturity (Figures 5B, C) from Mrs Susan Strauss, who maintains a shade-net enclosure. Although not new to science, another description of mature archegoniophores and sporophytes, this time from southern Africa, was deemed permissible, as Arnell's (1963) description, in which he mistakenly refers to the 'peduncle of the female organ' as furrowed, is very brief and is almost certainly not based on southern African material. Even Saxton (1931), who described the life history of *Lunularia cruciata* partly from southern African collections, had to wait many years, i.e. from 1908,

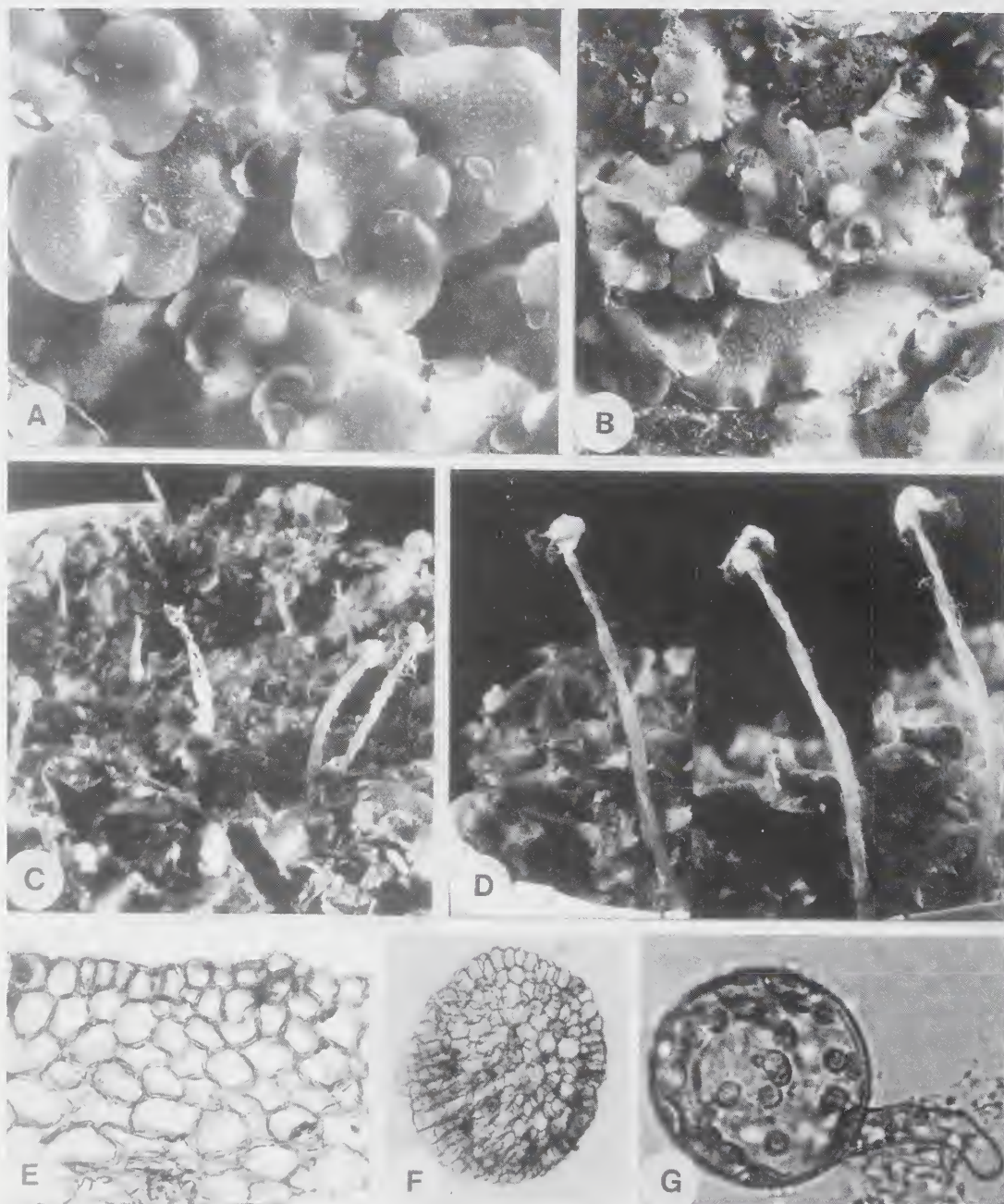


FIGURE 5.—*Lunularia cruciata*. A, thalli with androecial discs; B, thalli with young, still sessile archegoniophores; C, stalked archegoniophores; D, mature archegoniophore, shedding spores and elaters; E, portion of stalk in transverse section, showing cortical and medullary cells; F, seta in transverse section; G, germinating spore. A–G, S. Strauss 64. A, B, $\times 2.5$; C, $\times 2$; D, $\times 3$; E, $\times 175$; F, $\times 70$; G, $\times 700$. E–G, LM photographs.

when initially 'a small patch of fertile plants was found ... in the Municipal Gardens at Cape Town' [which he appears not to have described], until fruiting material was eventually forwarded to him from Dartmouth, England, in 1925–1928. The youngest stages of the archegoniophores were missing, however, and their description was only completed more than 20 years later, by Benson-Evans & Hughes (1954), based on English collections. Campbell

(1965) also added some supplementary notes regarding the early stages in New Zealand material. Schuster (1992) reports the species as relatively often fertile in the south of Spain, but rarely in North America. Sérgio & Viana (1973) found one-fifth of the collections in Portugal to have sporophytes. Germination of the spores (Figure 5G) was described by Groenland (1954), Chalaud (1932) and also by Campbell (1965) but, as far as I am aware, SEM

micrographs of the spores and elaters have not previously been published.

DESCRIPTION OF ARCHEGONIOPHORE, SPOROPHYTES AND SPORES

Juvenile archegoniophore sessile (Figure 5B), apical part roundly convex to shortly 4-lobed, ± 2 mm in diameter, with small, central swelling, lime-green and somewhat shiny, basally surrounded by densely imbricate layers of cottony, white scales with upper edges irregularly fringed with filiform cellular appendages (Figure 6F). *Archegonia* in 4 groups, up to 8 (or more) in each, of these only 1 or 2(3) or even none becoming fertilized, located between lobes, opposite indentations, and surrounded by furrows, with raised margins which rapidly grow out to form tubular involucre. By expansion of central domed region, all subsequently carried to underside, initially drooping, later almost horizontally spreading outwards in shape of a cross, from a common, reduced central disc lacking photosynthetic tissue. *Involucres* yellowish white, almost smooth, rather delicate, 5 cell layers (± 160 μm) thick, numerous oil bodies present, outer cells $35.0\text{--}75.0 \times 25.0\text{--}37.5$ μm , 4- or 5-sided, some long-rectangular; smaller, however, $25\text{--}30 \times 25\text{--}35$ μm , at margins of eventual distal opening, through which, by elongation of setae, capsules become exerted (Figure 5D), after rupturing calyptra; pseudoperianth lacking. When sporophytes nearly ripe, stalk elongates, trailing silvery white, thread-like filaments with it, archegoniophore still partially covered by scales, and foot of stalk surrounded by large, erect scales, up to 2500×2500 μm , cells 4-6(-7)-sided, $37.5\text{--}52.5 \times 22.5\text{--}25.0$ μm , filiform appendages consisting of elongated cells, $\pm 65 \times 20$ μm , linearly arranged in a single row. *Stalk* eventually up to 34 mm long, gradually narrowing upwards, translucent white, in transverse section

rounded to oval toward base, $825\text{--}950 \times 750\text{--}850$ μm , cortical cells in 1 row, $15.0\text{--}22.5 \times 12.5\text{--}25.0$ μm , outer walls hardly thicker, medullary cells angular, $35.0\text{--}47.5$ μm wide (Figure 5E), slightly thickened at corners, lacking rhizoid furrow as well as photosynthetic tissue, shaggy with scattered, white, thread-like filaments; after spores and elaters have been shed, soon collapsing. *Calyptra* enlarging with growth of sporophyte, its wall ± 4 cell layers (62.5 μm) thick, outer cells rectangular or polygonal, $45\text{--}60 \times 20\text{--}25$ μm , archegonial neck remaining attached. *Sporophyte* with foot subspherical, small, green; seta hyaline, $150\text{--}300$ μm in diameter, rapidly elongating to ± 2 mm, in transverse section (Figure 5F), cortical cells $30.0\text{--}32.5 \times 17.5\text{--}25.0$ μm , medullary cells round or isodiametric, $25\text{--}40$ μm wide, walls slightly undulate; capsule dark brown, obovoid, ± 1.25 mm long, wall unistratose, lacking thickenings, cells rectangular, $20.0\text{--}25.0 \times 12.5\text{--}15.0$ μm and 25 μm thick, tiny distal cap bistratose and soon shed intact, dehiscing lengthwise into 4 lanceolate valves, some bifid at apex, folding back to base of capsule and releasing numerous spores and elaters. *Spores* light brown, when fresh many filled with chloroplasts, apolar, triradial mark absent (Figure 6A), mostly spherical or ovate (Figure 6B), frequently with indentations (Figure 6C), wall thin, densely granulate (Figure 6D), diameter ($12.5\text{--}15.0\text{--}22.5$ μm); enlarging and germinating after 3 or 4 weeks (Figure 6G), a colourless germ rhizoid (Nehira 1983) emerging from it. *Elaters* light brown, bispiral (Figure 6E), longly tapering at both ends, $320\text{--}350$ μm long, $5\text{--}6$ μm wide in centre, tips 2.5 μm .

DISCUSSION

Various reasons have been suggested for the low incidence of sexual reproduction in *Lunularia cruciata* but no causal relationship could be found between its sexual fer-

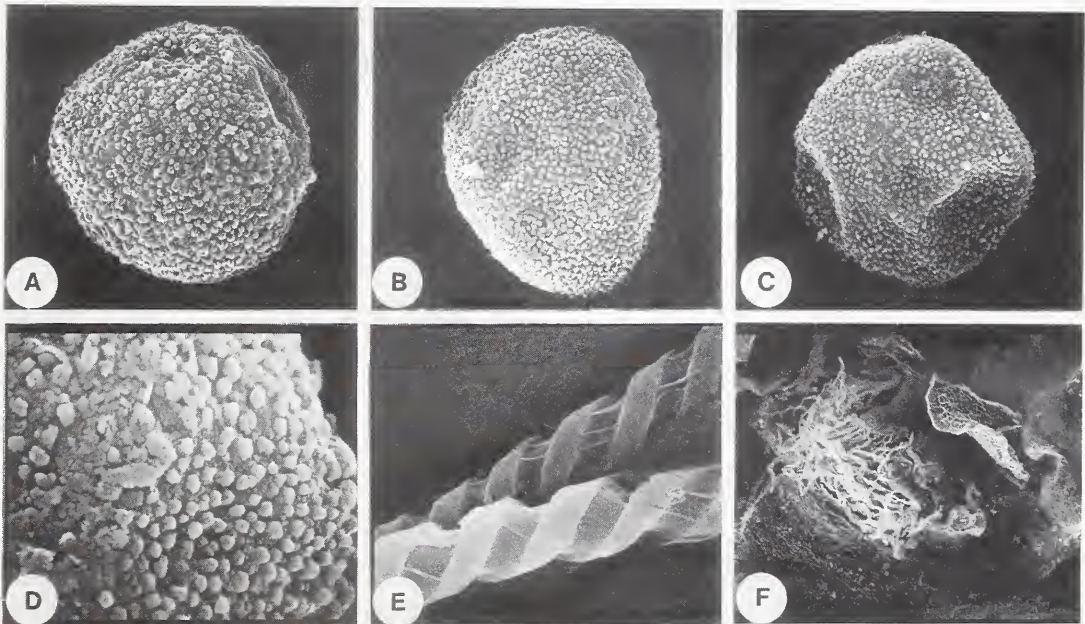


FIGURE 6.-*Lunularia cruciata*. A, round spore; B, ovate spore; C, indented spore; D, granular ornamentation on exine much enlarged; E, part of 2 elaters; F, young archegoniophore, covered with scales with long filiform appendages at margins. A, B, D, E, *S. Strauss* 64; C, *Angusto* LISU 147800; F, *Koekemoer* 1004. A, $\times 226$; B, $\times 199$; C, $\times 222$; D, $\times 612$; E, $\times 191$; F, $\times 31$. A-F, SEM micrographs.

tility or sterility and, for example, the presence or absence of the fungus, *Phoma lunulariicola* Ramsay, often associated with it (Benson-Evans & Hughes 1954). Unusual weather conditions were shown by Goodman (1956) to have no obvious correlation with the initiation of receptacles. On the other hand, Benson-Evans & Hughes (1954) found that there was an obvious correlation between the regular production of sexual organs and a Mediterranean type of climate. They also conclude that there is a preceding low temperature requirement in *Lunularia* and that this is comparable to vernalization in higher plants. Campbell (1965) refers to the work by Nachmony-Bascomb & Schwabe (1963) who demonstrated a response to photoperiod in Israeli plants. However, any interpretation of the behaviour of the New Zealand plants in the light of these findings was complicated by the fact that winter temperatures in New Zealand are much lower than those in Israel. Sérgio & Viana (1973) suggest 'that the availability of water is the limiting factor in the development of the sporophytes as it was shown by the geographic distribution of the fruiting plants'; and they continue: 'this distribution is correlated with a humid Mediterranean type of climate'.

As far as the southern African plants are concerned, it is possible that the formation of gametangiophores was initiated by the unusually severe winter we experienced in 1994. Although the plants were somewhat protected in Mrs Strauss' shade-net enclosure, it was unheated and they may have become 'vernalized'. Synchronous maturation of spermatozoids and eggs and their close proximity must have led to fertilization and the subsequent production of sporophytes several months later.

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I sincerely wish to thank Mrs Susan Strauss of Pretoria for bringing me plants of *Lunularia cruciata* with sporo-

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ERICACEAE

A NEW SPECIES OF *ERICA* FROM THE WESTERN CAPE

Erica karooica E.G.H. Oliv., sp. nov.

Rami puberuli. *Folia* 3-nata, erecta, 2–3 mm longa, lineari-oblonga, glabra, ciliolata; petiolo ± 0.5 mm longo, appresso. *Flores* 3–6-nati terminales; pedicello ± 1 mm longo, dense puberulo; bractea mediana, bracteolis subapproximatis. *Calyx* 4-lobatus, base puberula, breviter ciliatus et glandibus sessilibus rubris, viridis. *Corolla* 4-lobata, 1.3 $\times$ 1.0 mm, glabra, straminea, brunnescens, obconica. *Stamina* 8, libera, subexserta; antheris ovatis muticis; polline in tetradis. *Ovarium* 4-loculare, 0.5 $\times$ 0.5 mm, obovoidcum, glabrum, emarginatum; nectariis abscentibus; placenta in dimidio superiore; ovulis 8 in quoque loculo pendentibus; stylo exserto; stigmatibus latissime cyathiformi. Figura 7.

TYPE.—Western Cape 3321 (Ladismith): Ladismith Dist., southern foothills of Great Swartberg on Vaartwel/Bergplaas farms, waboomveld on steep, dry, stony, south slopes northeast of lower Bergplaas, 808 m, (–BC),

6-04-1994, *Oliver 10447* (STE, holo.; BM, BOL, E, K, MEL, MO, P, PRE, S, W, iso.).

Erect dense shrub to 1.25 m tall, single-stemmed. *Branches* wiry flexuose, very shortly puberulous with occasional glands intermixed, no infrafoliar ridges, bark grey flaking irregularly when old. *Leaves* 3-nate, erect, imbricate, 2–3 mm long, linear-oblong, subacute to obtuse, rounded in transverse section, sulcate, very shortly ciliate and with a few sessile glands when young, otherwise glabrous; petiole ± 0.5 mm long, appressed, shortly ciliate. *Flowers* 3–6 at ends of main branches and short lateral branchlets, erect; pedicel ± 1 mm long, densely puberulous, reddish; bract median, appressed, ± 0.7 mm long, oblong, terminally sulcate, glabrous, minutely ciliate, pale green; bracteoles subapproximate, like the bract but slightly smaller. *Calyx* 4-lobed, ± 0.8 mm long, green, lobes erect, $\frac{1}{3}$ – $\frac{2}{3}$ length of calyx, ovate to deltoid, subacute to obtuse, apically sulcate, puberulous at base,

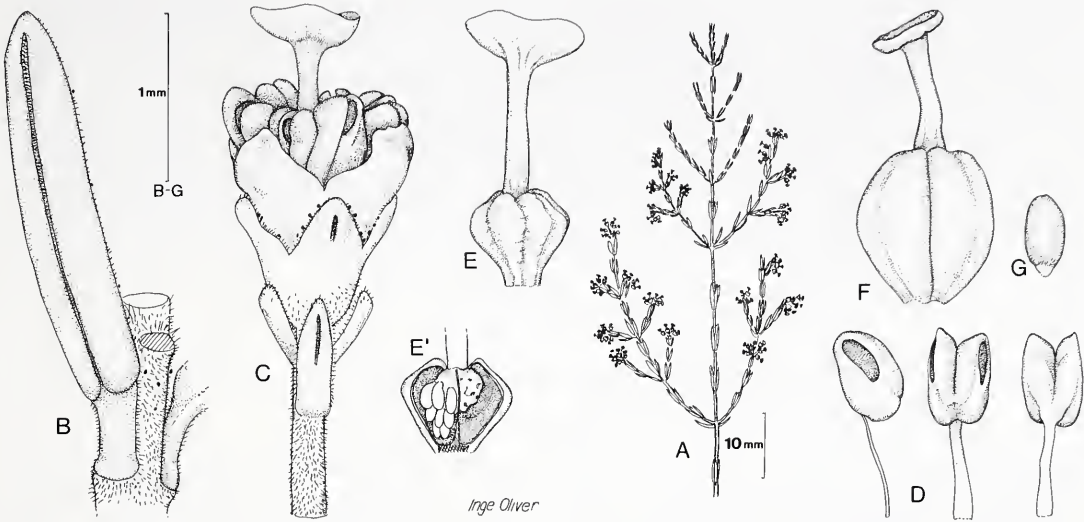


FIGURE 7.—*Erica karoovica* E.G.H. Oliv.: A, flowering branch; B, branchlet & leaf; C, flower; D, anther, side, front & back views; E, gynoecium; E', ovary, opened laterally; F, fruiting gynoecium; G, seed. Drawn from Taylor 10362 (STE).

shortly ciliate with hairs and a few sessile red glands. *Corolla* 4-lobed, 1.3×1.0 mm, obconical, glabrous, dull translucent cream soon turning brown, lobes erect to slightly incurved, $\frac{1}{3}$ length of corolla, subacute, sometimes sparsely crenulate. *Stamens* 8, free, erect; filaments linear 0.7 mm long; anthers subexserted, muticous, thecae ovate in outline, glabrous, golden brown, pore $\frac{1}{2}$ length of theca; pollen in tetrads. *Ovary* 4-locular, 0.5×0.5 mm, obovoid, 8-lobed, glabrous, emarginate, with no nectary glands at base, ovules ± 8 per locule, pendent, placenta confined to upper half; style exserted, ± 1.1 mm long, red; stigma very broadly cyathiform, red. *Capsule* 1.2×1.0 mm, narrowly cyathiform, septa split for $\frac{3}{4}$ their length, upper part of septa 50% on axis and 50% on valve; seeds 0.5×0.2 mm, slightly flattened ellipsoid, smooth and shiny, yellow to brown, with a distinct short paler elaiosome. Figure 7.

This new species is most closely related to the widespread eastern Cape species, *E. caespitosa* Hilliard [= *Philippia tristis* Bolus], but may be distinguished by its single-stemmed reseedling habit, densely hairy pedicel with a hairy base to the calyx, always two free bracteoles, open broadly obconic corolla with the anthers clearly visible being half exserted and a very broadly cyathiform stigma.

E. caespitosa, as its name suggests, is a low, multi-stemmed resprouter with a glabrous, or occasionally sparsely puberulous, pedicel and glabrous calyx, globose to broadly urceolate corolla with included anthers and obconic stigma. *E. caespitosa* occasionally possesses two bracteoles on the pedicel, but usually has none with the bract often fully recalcrescent and forming part of the calyx in the philippioid condition (Oliver 1988).

E. karoovica has small insignificantly coloured flowers that are developed for wind pollination (Rebello *et al.* 1985). At the type locality plants gave off small puffs of pollen into

the wind when disturbed. The flowers are very similar at first glance to those in the minor genera of the Ericoideae like *Salaxis* Salisb. and *Coccosperma* Klotzsch, and therefore would probably not attract much attention among collectors. The flowers are unusual in that the corolla is a very translucent white with the red immature anthers clearly visible inside. Soon after the stigma appears beyond the corolla mouth, the corolla loses its colour, dries out and turns brown before the anthers have appeared and shed their pollen. I have not noticed this feature in any other species.

The possession of an elaiosome on the seeds is a character that has never before been recorded in the Ericoideae. This is, however, not the only species that I have recently found, in the closer examination of *Erica* spp., to possess such an appendage. The biological implications of this character need some detailed field investigations.

The species is fairly widespread in the southern region of South Africa (Figure 8) with most of the collections coming from the mountains in and around the Little Karoo, hence the name. Within this distribution range the species occurs in a wide variety of habitats from low to high altitude. Most, however, occur on southern slopes of mountains in mountain fynbos on quartzitic soils. In the far west it occurs at low altitude, 500 m, in dry fynbos on Malmesbury shales. On the eastern end of the Great Swartberg it occurs on the summit ridges at 1 500 m. Surprising localities are those on the coastal plain east of Riversdale and north of Bredasdorp.

The nearest localities of *E. caespitosa* are in the Sneeuwberg west of Graaff-Reinet 130 km to the north and the Boschberg above Somerset East 180 km to the northeast.

Flowering period is from March to May.

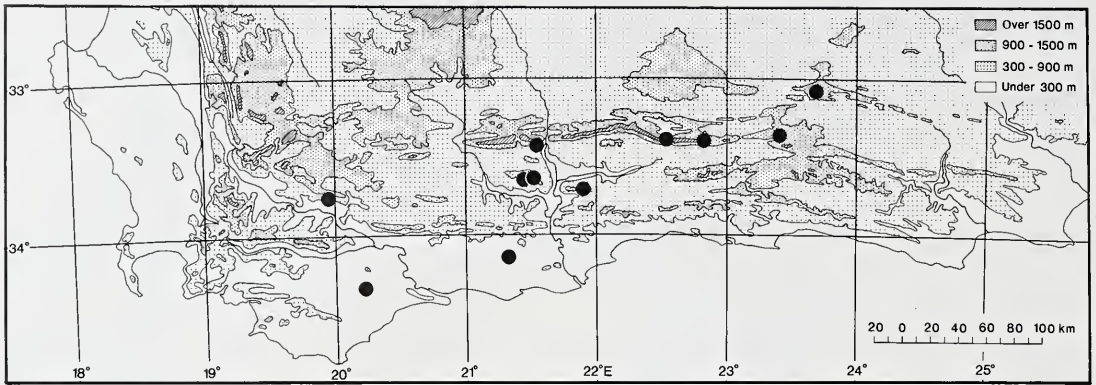


FIGURE 8.—Known distribution of *Erica karooica* E.G.H. Oliv.

Specimens examined

WESTERN & EASTERN CAPE.—3319 (Worcester): Robertson Dist., Klaasvoogds West, Kortrug, on SW-facing slopes of Langeberg on Farm Bergendal, 500 m, (–DD), 20-10-1989 (fruiting), *McDonald 1824* (BOL, K, MO, PRE, STE). 3321 (Ladismith): Ladismith Dist., Calitzdorp area, S foothills of Great Swartberg on Vaartwel/Bergplaas farms, waboomveld on steep S slopes NE of the lower Bergplaas Farm, 808 m, (–BC), 6-04-1994, *E.G.H. & I.M. Oliver 10447* (BM, BOL, E, K, MEL MO, P, PRE, S, STE, W); Ladismith Dist., Farm Bergplaas, waboomveld on steep S slopes, 790 m, (–BC), 9-04-1982, *Taylor 10362* (BM, K, MO, PRE, STE); Ladismith Dist., S slopes of Roodeberg, (–CB), 14-05-1950, *Esterhuysen 17140* (BOL, STE); Ladismith Dist., Rooiberg, above waterfall in Groenkloof below hut, 1 130 m, (–DA), 22-04-1977, *Taylor 9642* (K, PRE, STE); Ladismith Dist., Gamka Mtn, S slope SW of beacon, 1 000 m, (–DB), 23-05-1975, *Boshoff P139* (STE); Calitzdorp area, Gamka Reserve, Boskloof, on rugged sandstone slope, (–DB), 23-05-1975, *Esterhuysen 33843* (BOL, STE). 3322 (Oudtshoorn): Oudtshoorn Dist., Meiringspoort, (–BC), 25-08-1991, *Schumann 791* (PRE, STE); Willowmore Dist., eastern Swartberg on crest of Snyberg, 1 500 m, (–BD), 11-03-1991, *Vlok 2456* (STE). 3323 (Willowmore): Willowmore Dist., Zuurberg Poort, Farm Modderfontein, 824 m, (–AB), 22-09-1923, *Andrae 1040* (K, PRE, STE); Willowmore Dist., Witteberg [Witberg], peak N of World's View [Wildsview], 1 540 m, (–BA),

26-07-1986, *Vlok 1542* (STE). 3420 (Bredasdorp): Bredasdorp Dist., hills E of Vrede on Swellendam/Bredasdorp main road, 950 m, (–AC), 2-09-1994 (fruiting), *Oliver 10548* (STE). 3421 (Riversdale): Platkop, SE of the town, (–AB), 20-10-1987 (fruiting), *Rebello et al. 58/1* (STE).

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ASTERACEAE

A NOTE ON *URSINIA BRACHYLOBA*

Bremer & Humphries (1993: 93), made what they thought was a new combination in *Ursinia* for *Sphenogyne brachyloba* Kunze (1847: 21). However, N.E. Brown (1887: 670) had already made this combination. The correct author citation for this name should therefore be:

***Ursinia brachyloba* (Kunze) N.E. Br.**

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KUNZE, G. 1847. *Pugillus tertius plantarum*. *Linnaea* 20: 21.

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A NEW COMBINATION IN *COTULA*

Bremer & Humphries (1993) sank the South African species of the genus *Matricaria* under *Cotula*. They did not consider the varieties of *M. nigellifolia*; they merely came to the conclusion that this taxon belongs under *Cotula* (pers. comm.). PRE upholds the varieties under *M. nigellifolia* as described by De Candolle (1827), Harvey

(1865), Hutchinson (1917) and Hilliard (1977). It is therefore necessary to make the new combination.

***Cotula nigellifolia* (DC.) Bremer & Humphries var. *tenuior* (DC.) P.P.J. Herman comb. nov.**

Matricaria nigellifolia DC. var. *tenuior* DC., *Prodromus systematis* 6: 50 (1837).

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AUTHOR CITATION 'EX KRAUSS' IN NOMENCLATURE

In a number of recent articles on South African taxonomy, Krauss has been cited as the publishing author of species names, thus 'ex Krauss'.

C.F.F. Krauss was a collector who apparently did not describe the plants he collected, but used various specialists to describe them for him. These descriptions were put together for publication in a series of articles entitled *Pflanzen des Cap- und Natal-Landes gesammelt und zusammengestellt von Dr Ferdinand Krauss*. These articles appeared in the periodical *Flora*, Vols 27–29 (1844–1846). This information is clearly stated by Gunn & Codd in *Botanical exploration of southern Africa* (1981: 212).

The term 'ex' in the author citation of a plant name means that the person whose name follows the 'ex' was the person who validly published the plant name but was not the first person to **give** it a name (Jeffrey 1982: 89).

Consider the case of *Marchantia contracta* Bisch. ex Krauss cited in Bischler-Causse (1993). This author citation implies that Bischoff was the author of the name, but failed to fulfil all requirements for valid publication and that valid publication was later effected by Krauss. Bischoff, at the request of Krauss, provided the name and description and this was published by Krauss in *Flora* 29: 134 (1846). Therefore Bischoff is the sole author of the

plant name. According to Note 1 of Article 46.2 of the ICBN (Greuter *et al.* 1994) the word 'in' is sometimes used when the authorship of a plant name differs from the author of the publication in which it was validly published. It would therefore be 'Bisch. in Krauss' in the present example, but in such a case, 'in' and what follows are part of a bibliographic citation and are better omitted. The correct citation is therefore *M. contracta* Bisch.

A similar example published in *Flora* 27 (1844) is *Harpephyllum caffrum* Bernh. ex Krauss which appears in *Flora Zambesiaca* 2: 557 (1966). The correct citation is *H. caffrum* Bernh.

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The psocid *Liposcelis bostrychophilus* Badonnel (Psocoptera: Liposcelidae): an occasional herbarium pest

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Keywords: booklice, herbarium curation, herbarium hygiene, herbarium pests, insect pests, *Liposcelis bostrychophilus*, pest eradication, Psocoptera

ABSTRACT

The herbarium pest *Liposcelis bostrychophilus* is described and illustrated. Aspects of the insect's life cycle and eradication are discussed. Where possible, non-toxic methods, such as sterile-entry techniques of control, should be used. If infestations are epidemic and serious damage is being incurred, there may be no alternative but to use pesticides or fumigants.

UITTREKSEL

Die herbariumplaag *Liposcelis bostrychophilus* word beskryf en geïllustreer. Aspekte van die insk se lewensiklus en uitroeiing word bespreek. Waar moontlik, moet nie-toksiese metodes, soos steriele-ingangstegnieke vir beheer, gebruik word. Indien besmettings epidemies van aard is en ernstige skade sou berokken, is plaagdoders of berokingsmiddels waarskynlik onvermydelik.

INTRODUCTION

One of the most serious problems in herbarium curation, especially in tropical regions, is the protection of valuable plant specimens from damage by insects. In the past, various animal pests have been encountered at the National Herbarium in Pretoria (PRE), including cigarette beetles, cockroaches, rats and fishmoths. Of these, *Lasioderma serricorne* (F.), the cigarette or tobacco beetle, has caused the most severe damage to herbarium specimens (Retief & Nicholas 1988). The National Herbarium Pretoria is located on the southern African highveld, and conditions here are quite different from those encountered at one of its satellite herbaria, the Natal Herbarium (NH) in Durban. Unlike Pretoria, where conditions are usually moderate to cold and dry in winter, Durban has a more tropical climate, with warm and humid conditions. As a result, a psocid, rather than *L. serricorne* is the primary pest in this herbarium. In 1986, during one of these psocid infestations, samples of the insect involved were collected for study and identification. By obtaining a correct scientific name it was hoped that, through the literature, a greater understanding of the pest could be reached, including a suitable, safe method of eradication. The insect was identified as the common booklouse: *Liposcelis bostrychophilus* Badonnel (fide C. Lienhard of the Museum d'Histoire Naturelle, Genève), of the Order Psocoptera (Figure 1).

It should be mentioned, however, that these insects are not true lice, which belong to the Order Mallophaga, and that the common names booklice or barklice are therefore misleading. Although common names are generally of lit-

tle scientific value, the term psocid, given to members of the psocopteran family Psocidae, does seem more appropriate.

DISCUSSION

Psocid taxonomy and general information

Liposcelis Motschulsky belongs to the family Liposcelidae in the suborder Troctomorpha. In this suborder parthenogenesis is frequent, and Pearman (1928) believes that in many species the male is not a vital necessity for reproduction; certainly this is true of *Liposcelis bostrychophilus* which is an obligated parthenogen; males have never been found. *Liposcelis* is characterized by being moderately dorsoventrally depressed and completely apterous (without wings) in both sexes. The coxae are ventrolaterally inserted and their articulation with the thorax is therefore not visible from above. The broad hind femur has a dorsal, obtuse protuberance at its widest point. The genus contains a number of species complexes with inherent taxonomic difficulties; one such complex includes *L. bostrychophilus* and *L. corrodens* Heymons (Broadhead 1950).

Members of the family Liposcelidae can be distinguished by their dorsoventrally depressed bodies, elongate-oval abdomen, hindlegs not extended beyond the apex of the abdomen and antennae not longer than $\frac{1}{2}$ to $\frac{3}{4}$ the length of the body (Smithers 1985).

Most members of the family Liposcelidae are found in association with dry leaves or under bark, although some appear to be associated with grass galls or with ants' nests. A few psocids have become pests by inhabiting man-made structures (including homes) and damaging his resources (especially stored goods). Through commerce these particular species are now quite cosmopolitan in distribution.

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MS received: 1994-08-30.

although Broadhead (1950) points out that air currents may also help in the dispersal of these small insects, live specimens having been collected on air currents at altitudes of 150 m or more. These species are usually not harmful to man and are generally included in the category of nuisance, although they should be regarded as a warning that environmental conditions are becoming ripe for proliferation of other insect pests (Hickin 1985). Although not true ectoparasites, there are a few very rare reports of infestations of living animals (Gurney 1950), such as humans, dogs, chinchillas and possibly birds. However, psocids seem to occur on living animals only under exceptional, usually unhygienic circumstances.

Smithers (1967) lists 58 species of *Liposcelis*, although an anonymously annotated copy of this list housed at the Entomology Department of the Natural History Museum in London (seen in 1990) catalogues a further 44 names, constituting a genus of approximately 100 species, possibly more. The last detailed revision of the genus is that of Broadhead (1950), who listed only 24 species. According to Smithers (1985) 80 species of the Order Psocoptera (in some 34 genera) and 12 species (in three genera) of the family Liposcelidae have been recorded in southern Africa.

Psocid pests

Gurney (1950) reported that no more than a dozen psocids are known to be pests, but Mockford (1991) recorded some 50 species as occurring on stored foods. These pest species are usually soft-bodied, 1 to 2 mm long, wingless or with very short oval wings, with chewing mouthparts (Figure 2C, D) and a large, swollen postclypeus (the upper exoskeletal plate that covers the mandibles—Figure 2B); the antennae are thread-like with many segments, parthenogenesis is common, and the majority of species have six nymphal stages (although metamorphosis in the egg and nymphal stages is incomplete). They feed largely on microflora such as fungal molds but, being polyphagous, may also eat pollen and other organic materials, including dead animal (mainly insect) and plant remains (such as straw). In the food industry they have been reported as feeding on bananas, barley, biscuits, cereal products, chocolate, cacao fruits, cornflour, dairy products, fish meal, flour, linseed oil-cake, maize, meat products, nuts, oil seed, potato products, semolina, sugar, wheat, and even salt (Downing 1985; Pearman 1929, 1942). They are also often associated with packing materials (Society of Food Hygiene Technology, hereafter abbreviated as SFHT 1983), a factor which may have contributed to the widespread distribution of domestic species. Psocids tend to thrive and swarm in unused rooms where humidity and temperature are high and lighting poor. Populations have been reported to increase in heated buildings (Mockford 1991), and Spieksma & Smit (1975) have shown that *L. bostrychophilus* remains a common component of dust in centrally heated homes.

Besides causing damage by feeding, they are a nuisance if present in large numbers and may contaminate, directly or indirectly, foodstuff with which they come into contact. In 1981 the SFHT held a symposium at which the problems created by psocids for the food industry were

discussed (Downing 1985). The three most important psocid pests reported by the SFHT (1983) are *Trogium pulsatorium*, *Lepinotus patruelis* and *Liposcelis bostrychophilus*. However, whereas *Trogium* and *Lepinotus* tend to be associated with manufacturing premises and pallets, *Liposcelis* is usually the source of consumer complaints (Downing 1985). All three are of widespread occurrence in houses. *Liposcelis bostrychophilus* (which is brownish in colour) and *Trogium pulsatorium* (large, pale and whitish in colour) are both important pests in museums (Edward *et al.* 1980), and Broadhead (1950) report *Liposcelis entomophilus* (Enderlein), *L. liparus* Broadhead, *L. kidderi* (Hagen) and *L. terricolis* Badonnel as infesting both insect collections and herbaria. As demonstrated by the infestation at the Natal Herbarium in 1986, *L. bostrychophilus* can be added to Broadhead's list.

It should also be noted that most psocids are not pests. In fact, most of them play a vital role by making micro-organic debris and microflora available to the lower rungs of the food chain (Smithers 1985). Even psocids associated with human habitations may play a useful role in checking fungal growth in dark, damp places (Pearman 1928).

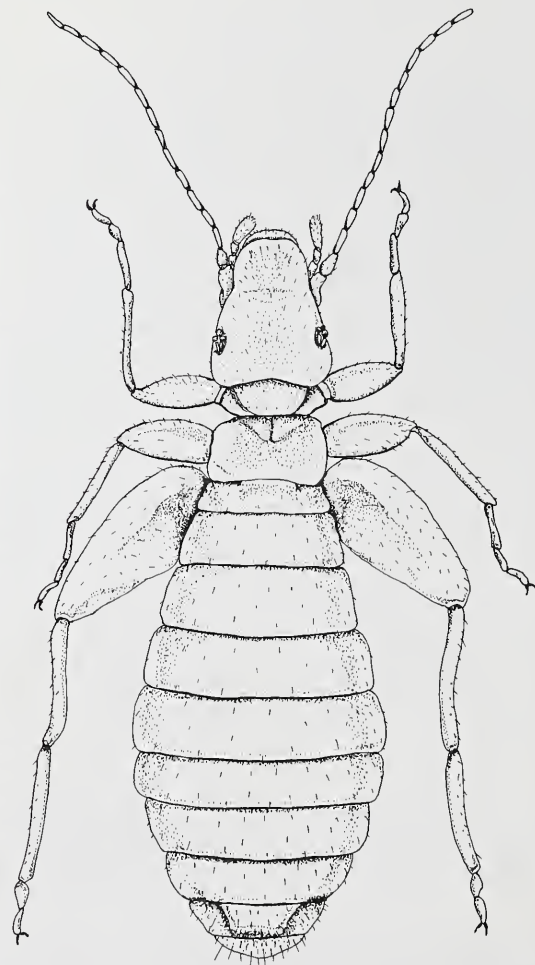


FIGURE 1.—*Liposcelis bostrychophilus*. Dorsal view, $\times 113$. Illustration by Heather Borchers.

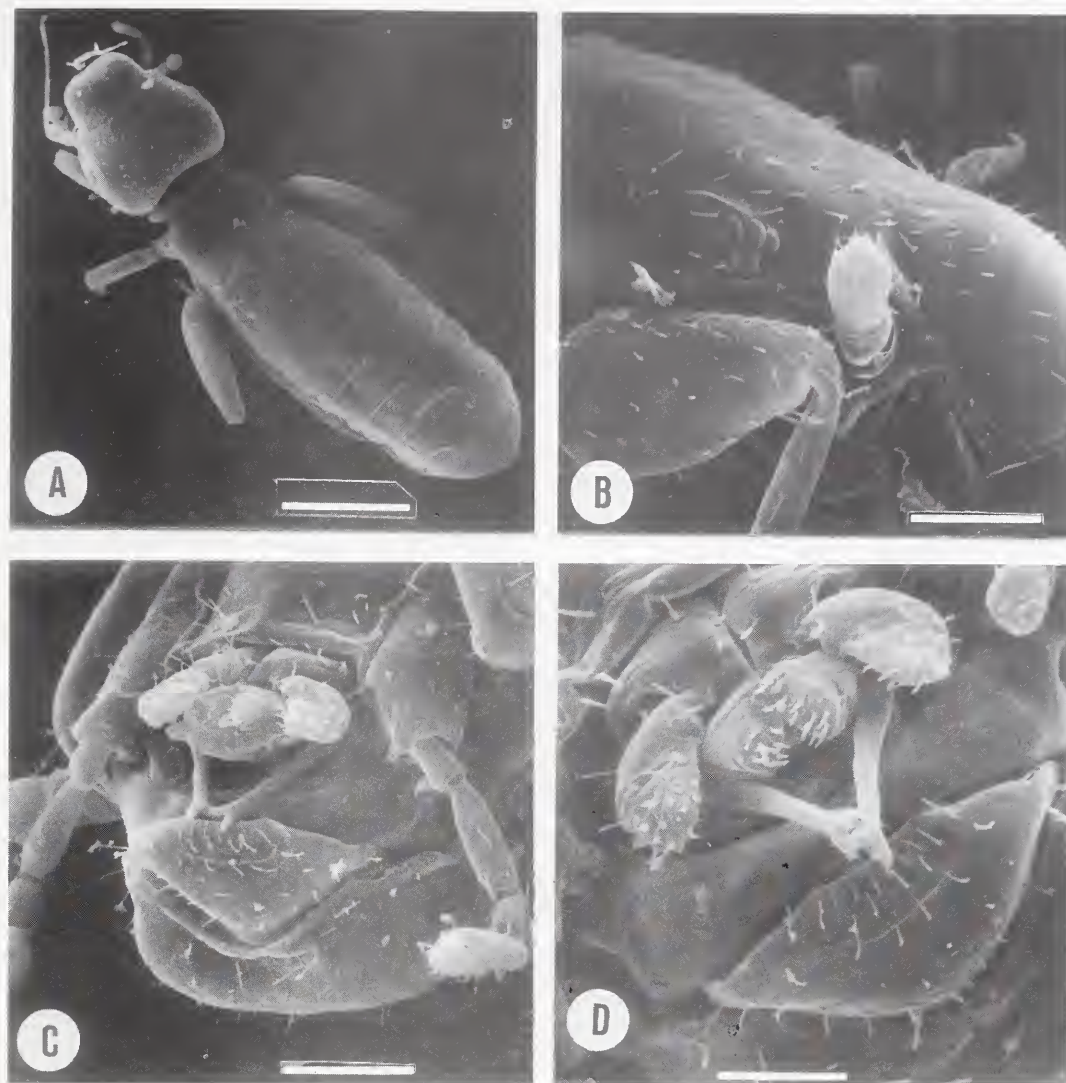


FIGURE 2.—SEM micrographs of *Liposcelis bostrychophilus*. A, dorsal view of whole insect, $\times 46$; B, side view of whole head, note small group of seven ommatidia and swollen postclypeus, $\times 202$; C, mouthparts, $\times 213$; D, close up of mouthparts, note strong, rod-like laciniae, $\times 352$.

Liposcelis bostrychophilus Badonnel

Liposcelis bostrychophilus was described by Badonnel in 1931. However, it has also been widely recorded as *L. divinatorius* (Müller) non Pearman, *L. divergens* Badonnel, and *L. granicola* Broadhead & Hobby (the latter two now regarded as synonyms of *L. bostrychophilus*). Broadhead (1950) presumed that the species probably originated in Africa and was later introduced into Europe; today it is cosmopolitan. It forms a species complex with *L. corrodens* and non-specialists may find these species difficult to tell apart.

Description

Liposcelis bostrychophilus is a minute insect, 1.0–1.5 (–2.0) mm long. It has a soft, semi-transparent, dull brown body sparsely covered with short hairs (Figures 1, 2). The

head is large and mobile and the neck is relatively narrow (Figure 2A). The compound eyes are reduced to groups of seven small ommatidia restricted to the side of the head (Figure 2B). The mouthparts comprise a pair of strong rod-like organs, the laciniae, which are furnished with three teeth at the end (Figure 2C, D). The antennae are long and thread-like. Wings are absent but the insect is capable of surprisingly rapid movement for its small size. The legs are short with a thickened hind femur which has a blunt tooth-like projection on the front margin (Broadhead 1950; Gurney 1950; Von Kéler 1953; Spieksma & Smit 1975; SFHT 1983; Mockford 1991).

Life cycle

On average about 100 sticky eggs, each more or less one third of the length of the female, are laid over a $\pm$

five month period. One female was recorded to have laid as many as 122 eggs during her life span (Spieksma & Smit 1975). The eggs, usually laid singly in cracks or on dusty surfaces, are smooth and bluish white or pearly coloured, but become dull as development proceeds. Under ideal conditions they take 10 days to hatch. The nymphs hatch from the egg by means of a saw-like egg-buster (Hickin 1985). These nymphs resemble the adult stage except that they are more fragile in appearance, paler in colour, and various body segment parts may vary in number with each instar. There are four nymphal instars, lasting 12–15 days in total, before the adult stage is reached. Within 2 to 3 days of reaching maturity, females start producing eggs. Adults may live for 150–175 days, sometimes less, and egg-laying takes place irregularly. There may be two to eight generations per year, depending on environmental conditions and food availability. No males are produced, reproduction taking place without the need for fertilization, i.e. by parthenogenesis. Under unfavourable conditions development is slower and the life cycle takes longer (Broadhead 1950; Gurney 1950; Spieksma & Smit 1975; SFHT 1983; Hickin 1985).

Factors affecting the life cycle

Temperatures of 25°C and a relative humidity of 75% present ideal conditions for *L. bostrychophilus*. The species is affected detrimentally by lower temperatures and humidity, but specimens have been known to survive short periods of freezing (Downing 1985). In cold buildings the insect may overwinter in the egg stage, but under warmer conditions such hibernation does not occur. Spieksma & Smit (1975) have shown that populations increase with increasing temperature and humidity. Their results show that (at the ideal humidity level) populations increase by 500% at a temperature of 21°C and by as much as 2000% at 27°C. Spieksma & Smit (1975) found no population increase at humidities below 40–50%, only slow growth at 50–60%, and rapid increases at 70–80%. Above 80% humidity, moulds become abundant on food sources and

help to increase the populations of the insect even more dramatically. The results of Spieksma & Smit (1975) apparently match those of Knülle & Spadafora (1969) who found the critical equilibrium humidity for *L. bostrychophilus* to be 60% relative humidity at 25°C. Critical equilibrium humidity is that level of humidity where it is possible for the insect to absorb moisture directly from the surrounding air; below this critical level the insect will tend to lose moisture and eventually die. Thus, under the right conditions of temperature and humidity, populations can experience an exponential growth. Such population explosions are no doubt helped by the fact that this species has a totally parthenogenic life cycle (Downing 1985).

L. bostrychophilus is negatively phototactic, moving away from the light into the dark. However, Spieksma & Smit (1975) have shown that the inhibiting effects of exposure to light on laboratory populations are minimal. Although this may be true under ideal conditions, it is unknown whether light may have a greater impact on population growth if environmental conditions are unfavourable and food resources limited. Spieksma & Smit (1975) have also shown that yeasts, if present with other food sources, accelerate population growth.

Damage

Although feeding primarily on microscopic flora, particularly fungi (including naturally occurring yeasts), these insects may also eat and damage other organic matter, including organically produced glues and pastes used for binding books or mounting specimens. They also tend to damage paper that has become damp and mouldy. Of more importance to curators, herbarium specimens themselves (not just their mounting boards) may be attacked, causing a fine powder to be scattered around the eaten and therefore damaged plant organ. Such damage may be inflicted on a wide range of dried plant specimens, but is usually confined to delicate flowers, such as those of *Wahlenbergia* (Figure 3A, B), although on rare occasions,

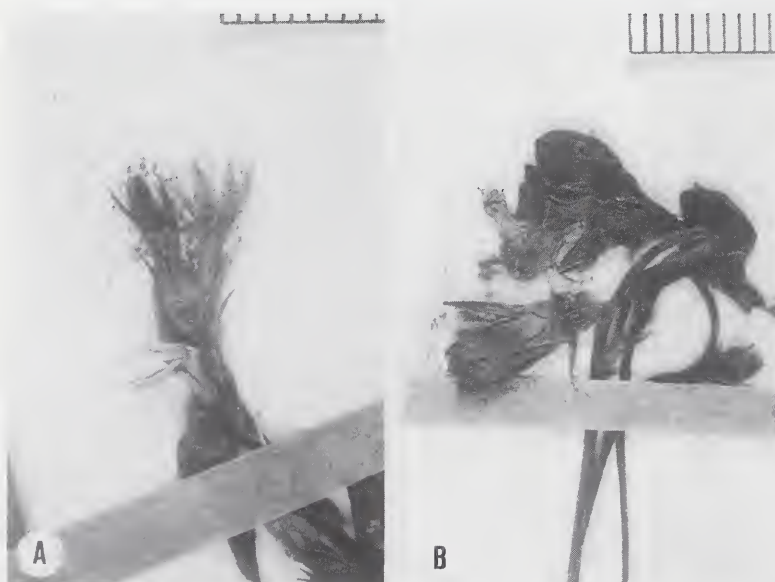


FIGURE 3.—A, B, herbarium specimens of *Wahlenbergia* spp. showing *Liposcelis bostrychophilus* damage. Note the debris (mostly faecal) surrounding partially eaten flowers.

woody structures may also be damaged, such as *Maytenus* stems. Unfortunately, psocids are usually only spotted when populations are high and damage already advanced. When infected herbarium boards are exposed to bright light they display a mass of tiny, pale brown bodies frantically dashing for shelter. If squashed, these insects will stain paper, including herbarium sheets. This staining of paper is particularly distressing to curators of valuable archival material, especially books and old manuscripts.

Control and eradication

If possible, non-toxic methods of control and eradication should be used; however, if infestations are epidemic and serious damage is being incurred, there may be no alternative but to use pesticides or fumigants. After collection in the field, plant specimens should be dried as quickly as possible to prevent the growth of fungal mycelia or yeasts on and within the specimen; the presence of these microfungi will only encourage psocid infestations. Sterile-entry techniques should be practiced, with herbarium collections being sealed off from the outside environment as much as possible. This must include non-herbarium rooms or offices near or adjacent to the herbarium itself. Before being transferred directly to the sealed building housing the collections, specimens should be frozen at temperatures below -8°C for 48 hours in a building separated spatially from the herbarium (Forman & Bridson 1989). Other physical methods of pest control (such as heating in a microwave oven) may also be practised as part of a sterile-entry procedure (Stansfield 1989).

However, all these physical methods affect plant specimens in undesirable ways (some albeit more than others) and so decrease their scientific value. An alternative to physical sterilization is chemical sterilization. Suitable chemicals are, however, all poisonous and care has to be taken when using them. Forman & Bridson (1989) list and discuss some of the more common treatments presently used by herbaria. Unfortunately, these chemical methods may also damage plant specimens. Herbaria should therefore decide how their collections are to be used before selecting a suitable physical or chemical sterilization technique (some herbaria combine elements of both). For instance, herbaria in which the removal and growth of spores or seeds is important, should definitely not heat or treat specimens in microwave ovens, even though this technique does not affect gross pollen structure (Arens & Traverse 1989). Freezing seems to be the best of the physical methods of sterilization, although this technique may affect seed and spore viability and may also turn incompletely dried succulent plants black and mushy. Poisons mixed with alcohol or other tetracarbons (mercuric chloride if mixed in alcohol and lauryl pentachlorophenolate [LPCP] if mixed with white spirit) may damage plant microstructures, particularly if these contain lipids. Such microstructures are often important taxonomic characters and need to be preserved intact. There is also a chance that very toxic and deeply penetrating poisons (such as mercuric chloride mixed in alcohol) may kill spores and seeds. Unfortunately, it is usually these types of poisons that are most effective for preventing insect attack.

The extraction of DNA samples from herbarium specimens (especially extinct species) may soon become routine and it is not yet known how present sterilization treatments may affect this important plant component. In particular, exposure to gamma radiation (used by a few institutions) may affect the DNA structure of some pressed plants. Unfortunately, because pests are such a problem in the tropics, herbaria situated here often have little choice but to take what they see to be the lesser of a number of evils. However, such herbaria should be encouraged to send pristine (i.e. physically undamaged) duplicates to temperate herbaria where they may be useful to systematic and conservation researchers.

The one major weak link in the life cycle of *L. bos-tryophilus* is its intolerance to low humidity. If the humidity of a building can be maintained below 50%, infestations of this pest should not occur. This may necessitate the installation of air-conditioning in herbaria that suffer repeated plagues of this insect. Herbaria unable to install air-conditioning, or in which the air-conditioning is proving ineffective in maintaining the humidity below 50%, may try putting a desiccant, such as silica gel, inside the herbarium cupboards. Silica gel removes moisture from the air and, being non-toxic, is people-friendly. Unfortunately, silica gel needs to be replaced or dried every three months (shorter intervals may be needed in very humid localities) if it is to remain effective. This procedure is therefore labour-intensive and costly. Another advantage of keeping the humidity low is that it helps to eradicate other insect pests, including the more commonly encountered cigarette beetle.

Some publications advocate humidity control in conjunction with fumigants or insecticides (Downing 1985; SFHT 1983), and such combination treatments may be needed in tropical situations where infestations can cause irreparable, costly damage if not checked. However, herbarium curators should be aware that poisons, by their very nature, are potentially harmful to man; some may cause allergies, illness and even death if not administered properly. If in doubt, experts should be hired to apply or administer fumigants and pesticides that are extremely toxic (see Bot *et al.* 1987; Stommel 1991). Localized infestations can be controlled or exterminated using commercially available dry sprays that do not mark or damage herbarium specimens (Retief & Nicholas 1988).

Resin blocks impregnated with dichlorvos have also been used to eradicate infestations, the insecticide being slowly released into the atmosphere over a three month period. Most of the arguments against the use of dichlorvos are based on anecdotal accounts (Bartle 1991) which tend to appear in the popular rather than scientific press (Sapa-Reuter Washington 1988). The substance was used in a wide range of household insect sprays in southern Africa (Central Standardization Committee 1978). Dichlorvos is an organophosphate that inhibits the functioning of nerve-related enzymes. It is therefore a poison and should be handled sparingly and with caution. Fumigants or foggers containing dichlorvos are a fairly effective and cheap way to eradicate or control infestations; this makes them attractive to herbaria with limited finances, which are unable to afford more costly treatments. In some countries dichlorvos foggers are readily available and may be

purchased in supermarkets. The poisonous ingredients take 48 hours to break down and herbarium staff should not be allowed into fumigated rooms during this period, also the effects of overexposure to high concentrations can be extremely serious (De la Viña *et al.* 1990; Anonymous 1991; Bartle 1991).

A double dichlorvos fogger fumigation technique (timed in such a way as to eradicate all stages of the life cycle of the cigarette beetle) was used with some success at the National Herbarium Pretoria in 1988. The technique was not costly and, wearing specially designed protective masks, the staff were able to administer the treatment themselves. It cannot be emphasized strongly enough that curators who are unsure of how to administer or apply poisons of any kind should seek expert help. They should also be aware of the risks involved and communicate these to staff that may come into contact with poisonous substances under working circumstances. Curators concerned with the welfare of their herbarium staff should see that they continually receive in-house or out-house education on all matters concerning herbarium hygiene; especially where health issues are concerned.

Insect pheromones are probably non-toxic to humans and are being used more and more as part of an effective insect pest control programme in some institutions (Anonymous 1989; Biological Control Systems pamphlet $\pm$ 1990a, b). Experiments using a pheromone for the cigarette beetle, *Lasioderma serricorne*, were initiated at the National Herbarium Pretoria in 1990. These sex-attractants (if used in connection with specially designed traps) may be effective in reducing insect populations but not in eradicating them. It must be remembered that these chemicals affect neither the females of the population nor sexually inactive or immature males. The fact that they do not eradicate pest populations is their biggest drawback as effective weapons against infestations; even a minimal pest population can continue to cause damage and the potential for disaster remains ever present. The major role the pheromone traps can play in pest control in herbaria is to act as an infestation warning device and for monitoring the course of such infestation. Usually, infestations are only noticed by herbarium workers when the numbers of the pest are already high and damage therefore quite substantial. Pheromone traps can help detect infestations before they reach this point and so alert herbarium staff to the problem at a time when damage can be minimized and pest populations isolated and destroyed. An insect-produced chemical holding greater promise than pheromones appears to be ecdysins. Apparently this chemical disrupts moulting, an essential process in the insect life cycle.

Although *Liposcelis bostrychophilus* may not cause as much damage to herbarium specimens as the cigarette beetle, the presence of this psocid should be seen as a warning that conditions are ripe for infestation by other, more destructive insect pests (Hickin 1985). This being the case, their presence should be viewed by curators with some concern.

CONCLUSION

The control of herbarium pests is of primary concern to all herbarium curators, especially in tropical regions of the world where ideal conditions for pest infestations occur. Hot, humid areas, such as those found along many tropical and semitropical coastlines, are ideal for the growth of the psocid *Liposcelis bostrychophilus*. Under ideal conditions in tropical herbaria, populations of these wingless, parthenogenic insect pests can build up very rapidly and so cause damage to books, specimens and herbarium packaging. Sterile-entry techniques, coupled with a controlled humidity lower than 50%, will generally eradicate or prevent infestations by these particular insects and should, therefore, be tried in preference to application of toxins. However, persistent infestations or those reaching epidemic proportions may call for sterile-entry and/or low humidity conditions, coupled with a fumigation or with the application of pesticides, if irreparable damage is to be prevented.

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OBITUARIES

WINSOME (BUDDY) BARKER (1907–1994)

The death of Winsome Barker (Figure 1) on 27 December 1994 at Wynberg, Cape, was more than just the close of a long chapter in the history of Kirstenbosch. It was—particularly for the Compton Herbarium—the end of an era. From 1929 when she arrived at Kirstenbosch to take up the Solly Scholarship until the late 1980's, when increasing infirmity prevented her from visiting the herbarium, her entire life revolved around the collection she built up with such devotion and diligence. Sadly, so many years have passed since her retirement in 1972 that now there are few members of the present staff of the National Botanical Institute who still remember her or are even aware of the magnitude of the contribution she made over a period of 43 years. In short, the story of her life and work is essentially the history of the founding and early development of the Compton Herbarium at Kirstenbosch.

Winsome Fanny Barker, the daughter of William Joseph Barker of Seaham, County Durham and his wife Beatrice (née Cusens), was born at Jamestown in the Eastern Cape on 23 September 1907. The family later moved to East London where her father became senior history master at Selbourne College and subsequently Inspector of Schools for the Eastern Cape. After matriculating from East London Girls High School, Winsome proceeded to Rhodes University College at Grahamstown to take a B.Sc. in Botany and Zoology, graduating in 1928 with the highest marks in her class for which she was awarded the Junior Captain Scott medals in both major subjects. She declined a University Scholarship to undertake an M.Sc. in Botany, but instead accepted the Solly Scholarship offered by the newly established National Botanic Gardens at Kirstenbosch for a young graduate wishing to study the South African Flora—a much more appealing option to Winsome's mind than getting further involved with academic botany. This was probably the most important decision in her life.

Thus, early in 1929 Miss Barker arrived at Newlands Station where the Kirstenbosch pony and trap were waiting to transport her down leafy oak-lined lanes to Kirstenbosch, then still a rather inaccessible countryfied destination where she finally disembarked at Pearson House, the garden's hostel for lady staff members. Apart from a brief interlude it was to be her home until 1972.

The director, Prof. R H Compton, was away at the time and so Buddy (as she was known to her friends) found herself placed under the wing of Louisa Bolus who was to be her guide and mentor for the two year duration of the Scholarship. It was a fortuitous start. Mrs Bolus, Curator of the Bolus Herbarium, then housed at Kirstenbosch, was a dedicated, thorough teacher; Miss Barker an eager receptive student. Buddy received a sound practical exposure to the current methods of plant taxonomy as well as a rigorous training in what may best be described as 'Bolusian' methods of herbarium practice and manage-

ment. Field work was not neglected either. Yet again the potent influence of Louisa Bolus made itself felt. Here Buddy describes her first serious collecting expedition:

'It was Mrs Bolus who took me on my first botanical collecting trip to the North Western Cape, where at Nieuwoudtville in an exceptionally good season. I saw my first spring display in all its glory, an unforgettable memory, which will remain with me always, as being more wonderful than my wildest dreams could have imagined. The wealth of species, as well as their beauty astounded me, and my ambition to be a systematic botanist began to crystallise.'

At the conclusion of her scholarship term Buddy was contracted to work in the herbarium at Kew by the Bentham Trustees and there she further broadened her experience in herbarium practices for some 2½ years between February 1931 and July 1933.

But Kirstenbosch soon beckoned again and in September 1933 she was offered an appointment as Botanical Assistant to the Director at a salary of £18 per month.



FIGURE 1.—Winsome Fanny Barker, photographed in 1973, a year after her retirement.



FIGURE 2.—The director's office in the nursery at Kirstenbosch, first home of the Compton Herbarium 1935–1940. Here Miss Barker assembled the first 18 cabinets of specimens before moving to the present herbarium building in April 1940. Note the plant press on the front step.

Although initially only a temporary position it was the first purely scientific post created by the Trustees of the National Botanic Gardens. Miss Barker's duties in the original words of her letter of appointment: 'would chiefly involve work more or less connected with systematics'. This was indeed to be the case although the circumstances under which she had to work were rather unusual in that her salary was paid by the National Botanic Gardens yet she effectively worked within the precincts of the Bolus Herbarium contributing material to their collection which of course belonged to the University of Cape Town. However, this anomalous situation did not last long. Indeed, after several years of mounting tension between Prof. Compton and Mrs Bolus regarding the siting of the Bolus Herbarium on the Kirstenbosch estate, matters came to a head in 1934 when the University agreed to Mrs Bolus' request to re-locate the Bolus Herbarium on their newly developed campus at Rondebosch. Thus in appointing Miss Barker, Prof. Compton astutely anticipated the even-

tual removal of the Bolus Herbarium from Kirstenbosch. Early in 1935 Miss Barker moved from the Bolus Herbarium to the director's office in the nursery at Kirstenbosch where under Prof. Compton's supervision she began to accumulate material for an independent gardens herbarium (Figure 2). (This historic building which housed the first cabinets of the gardens herbarium was demolished in March 1995 to make way for a new conservatory.) However, although Compton and Miss Barker began to build up the Kirstenbosch Herbarium as an independent collection in 1935, four years passed before the trustees of the National Botanic Gardens formally resolved, in October 1939, to start a new herbarium, the Bolus Herbarium having vacated the herbarium building at Kirstenbosch a year earlier in May 1938. In addition to Miss Barker's salary, expenditure of a further £350 for the first year was sanctioned to cover the salaries of other necessary personnel and the cost of acquiring preliminary equipment.



FIGURE 3.—Winsome Barker examining specimens in the present Compton Herbarium building ± 1948.

Thus it was that on April Fool's day 1940, the embryo 18-cabinet National Botanic Gardens herbarium was moved from the Director's office into the empty structure previously occupied by Bolus Herbarium. By the end of that year a further 14 cabinets of specimens had been added bringing the total to 32. There had been a great deal of growth since those humble beginnings in 1935 for which Buddy Barker was almost entirely responsible. Recognising this achievement, her salary was raised to £22 10 shillings as from 1 January 1941 but, more importantly, Prof. Compton informed her of her new responsibilities: 'it is understood that you will take control of the work of the herbarium for which you will be responsible to the Director of the Gardens'. The gardens herbarium was now a functional entity with Buddy Barker at the helm (Figure 3). Under her direction it was about to enter a long phase of sustained growth despite many difficult years of financial privation enforced by wartime and post-war economic stringency. Frugality and thrift were at all times the watchwords.

At the outset Buddy set exceptionally high standards with regard to the quality of the material incorporated. She developed a technique for laying out dissected floral parts on gummed card, invaluable in the case of fugacious petaloid monocotyledons and certain succulent groups such as the Asclepiadaceae. With limitless patience she assembled complete sets of material for those difficult groups like the Amaryllidaceae—where leaves, flowers and fruits are produced at different seasons, until complete sets of a plant's life history could be arranged on a herbarium sheet instead of merely one phase as is so often the case. All this material had to be carefully labelled and cultivated in shade houses adjacent to the herbarium. Some of the horticulturists like Harry Hall worked closely with her cultivating specimens for which different developmental stages were needed but more often than not Buddy found herself in the role of horticulturist, repotting, spraying, weeding or watering the research collections herself.

By the mid 1950's the herbarium had grown to 70 000 sheets, increasing to 110 000 sheets by the time she retired. (Over 10 000 were her own collections made mainly in the western Cape and Namaqualand.) Practically every one of these sheets passed through her hands or was subjected to her critical scrutiny at some stage during their processing while the majority are inscribed in pencil in her neat distinctive handwriting towards the lower right hand corner.

Probably the most dramatic development that took place during her curatorship was the transfer of the South African Museum Herbarium to Kirstenbosch in 1956. This historically priceless 100 000 sheet herbarium founded in 1825 was offered to Kirstenbosch on permanent loan, provided the curator, Dr Joyce Lewis and her assistant could be accommodated on the staff. For practical, archival, and historical reasons the two herbaria were never merged but the staff had to be integrated. It was a potentially touchy situation. The end result was that Buddy Barker remained Curator and assumed most of the administrative duties while Joyce Lewis became full time research officer. However, Buddy always respected Joyce's association with the South African Museum Herbarium, and Joyce

continued to curate it as well as draw and refile loans until her death in 1967.

A steadfast commitment to the goal of building up the herbarium meant that there was little time available for research yet despite these constraints she maintained a strong interest in the Amaryllidaceae and Liliaceae (*sens. lat.*) especially *Lachenalia* on which she published extensively. Regrettably, Buddy never completed her long awaited revision of the genus. All her publications were illustrated with her own drawings. Through the influence of her mother (who was herself an accomplished artist), Winsome was encouraged to draw and paint from early childhood. By the time she had graduated from University, she had developed into a skilled botanical illustrator. At least 35 of her colour plates were published in *The Flowering Plants of South Africa* between 1930 and 1938. The Royal Horticultural Society in London acquired a fine set of her watercolours depicting different forms and variations of *Agapanthus*. Some of these were used to illustrate Frances M. Leighton's 'The genus *Agapanthus* L' Heritier' (*Journal of South African Botany* Suppl. Vol. 4, 1965). By far the largest collection of her work (now held in the Compton Herbarium at Kirstenbosch), is a portfolio of 107 as yet unpublished colour plates of *Lachenalia*, painted between 1930 and about 1950 to illustrate a planned revision of the genus (Figure 4).

As if developing and running the herbarium, providing an identification service, publishing papers and preparing botanical illustrations were not enough, Buddy also found herself responsible for training the Solly Scholars. In all, twelve young graduates enjoyed the benefit of the same exhaustive training in herbarium work that she herself had received. Eventually however, inflation so diminished the value of the scholarship that it lapsed into a state of dormancy. Nevertheless, in its heyday, its influence was considerable and many ex-Solly scholars who were trained under Buddy came to hold key positions in herbaria throughout South Africa.

I first met Buddy in June 1958 when, as a schoolboy, I brought a few plants to the herbarium which I had not been able to identify myself. Well do I remember the courtesy with which she received me, the help I was given and the thrill of handling the herbarium sheets. I remember too being struck by the quiet, scholarly, almost monastic atmosphere of the old building set on a hillside above the garden, in dense natural fynbos alive with sugarbirds, bulbuls and white-eyes. It seemed to me to be a very desirable place to work. The whole establishment had its own distinctive atmosphere which mirrored her own temperament—disciplined and orderly. Buddy was a modest self-effacing person who eschewed the limelight and was never happier than when she was getting on with the job she did so well. Her natural restraint sometimes made her appear slightly aloof to strangers yet few realised this was merely a mask that hid a shy sensitive personality. There were undoubtedly times when she felt frustrated that she had not managed to do more research, yet she found great fulfillment in developing the collection, which became the Compton Herbarium, from its very inception into a viable institution, thereby laying the foundations for future research in plant systematics at



FIGURE 4.—*Lachenalia rubida* Jacq. painted by Winsome Barker in 1930. This is one of a collection of 107 of her colour plates of *Lachenalia*.

Kirstenbosch. It was an outstanding achievement in anyone's terms for which she will be remembered and honoured as one of the National Botanical Institute's great pioneers. Her name is commemorated in

several South African plants, among them *Leucadendron barkeriae* I. Williams, *Haemanthus barkeriae* Snijman, *Lachenalia barkeriana* U. Müll.-Doblies and *Romulea barkeriae* M.P. de Vos.

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ALAN PERCY-LANCASTER (1944–1995)

Alan Percy-Lancaster passed away on Saturday 3 June 1995. He had a heart attack whilst tending his garden in Pietersburg in the Northern Province, South Africa. Thus, southern African botany, and in particular those of us interested in succulent plants, lost a friend and indefatigable collector and field naturalist (Figure 5).

Alan was born in New Delhi, India, on 19 June 1944 and spent his early years in India. His deep love for and appreciation of plants in general undoubtedly stems from the fact that his father, grandfather and great grandfather were all professional horticulturists (Khoshoo 1966). The young Alan accompanied his parents to South Africa where they immigrated in 1956. Finding it difficult to secure employment, they eventually settled in Zimbabwe, then Southern Rhodesia, in 1958. Here he received his secondary school training at the Ellis Robins High School in Salisbury (now Harare), after which he completed a three year contract with the British South Africa Police in 1965. He then joined the Government Veterinary

Department and spent the next nine years at various stations in Zimbabwe. In 1974 he moved to South Africa and settled in Gravelotte in the eastern Transvaal Lowveld. He subsequently resided in Tzaneen, and at his untimely death lived in Pietersburg, where he was self-employed.

Alan was initially interested in exotic orchids and hybrids of *Amaryllis* L. (Kimberley 1989). One wonders whether this interest was stimulated by his grandfather who was a noted hybridiser of *Amaryllis* and other genera (Khoshoo 1966). However, during his career with the Government Veterinary Department in Zimbabwe, particularly while stationed at Melsetter (now Chimanimani) and Chipinga (Kimberley 1982), Alan's interest was extended to the genus *Aloe* L., and indigenous orchids. In 1970 he joined the Aloe, Cactus and Succulent Society of Zimbabwe and thereby started a long involvement in succulent plant collecting and field observations. His numerous field trips soon led to the discovery of new localities for known species (e.g. *Euphorbia halipedicola* L.C. Leach and *Poly-*

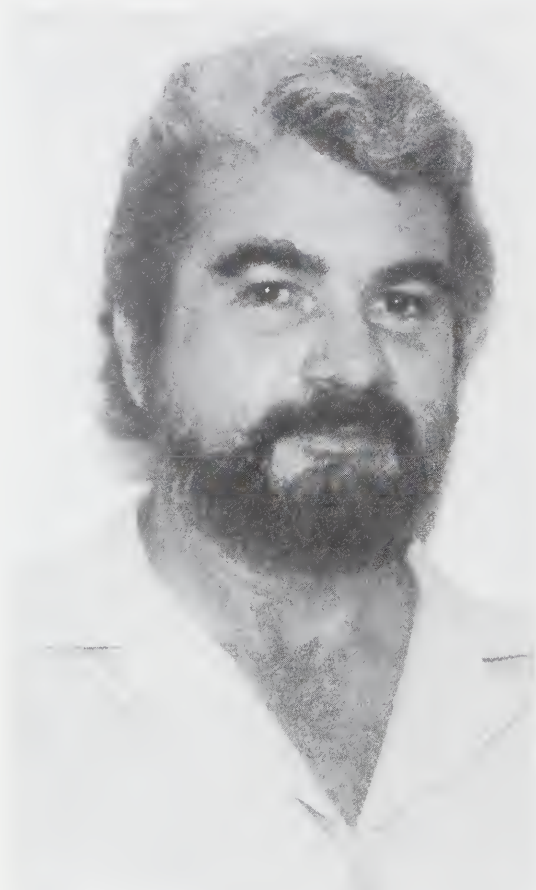


FIGURE 5.—Alan Percy-Lancaster (19 June 1944–3 June 1995). Photograph taken $\pm$ 1988.

stachya gohungensis Rechb. f.), a trend that continued after his emigration to what was then the Transvaal Province of

South Africa. Some of his other collecting achievements include finding a number of new species of *Brachystelma* R. Br., e.g. *B. gemneum* R.A. Dyer, and new species of *Ceropegia* L. and *Raphionacme* Harv., and a new variety of *Euphorbia lydenburgensis* Schweick. & Letty.

Alan Percy-Lancaster has collected about 2000 plant specimens, mostly in Zimbabwe, the Northern Province of South Africa and the Eastern Transvaal Province, and has contributed various papers on the genera *Aloe* and *Euphorbia* L. to *Excelsa*, the journal of the Aloe, Cactus and Succulent Society of Zimbabwe. His herbarium specimens are in SRGH and PRE. He was also a popular lecturer at congresses where he freely shared his vast knowledge of succulents from Zimbabwe and the northern territories of South Africa. In his spare time he was working on the Zimbabwean species of *Brachystelma* and *Ceropegia*, and he was a keen stamp collector. He is commemorated in the plant names *Pachycymbium lancasteri* Lavranos and *Brachystelma lancasteri* Boele, both species of the Asclepiadaceae.

Alan is survived by his wife Anna (née Menage), whom he married in 1965, and three daughters, Elayne, Liesl and Annabel.

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FRIEDRICH VON BREITENBACH OMS (1916–1995)

The study of trees in southern Africa suffered a grievous loss on 21 June 1995 when Dr Friedrich von Breitenbach (Figure 6) was killed in a motor accident in Pretoria. 'Oom Boom' was in every way a larger-than-life character, and those who met him are unlikely to forget the experience. The one overriding characteristic which impressed all those who knew him was his enthusiasm for all that he tackled. He possessed a thorough knowledge of dendrology, and was conversant with numerous other disciplines.

'Fried' von Breitenbach was born in Königsberg, East Prussia (then part of Germany, now Kaliningrad, Russia) on 1 August 1916. He was an only child, and was orphaned at the age of two. He was educated first at the Technische Hochschule, Dresden, 1935–1939, and then at Königsberg University, 1939–1943, graduating Dip. Forstingenieur, Dr.Jur., Dr.rer.nat. He was seconded from the army as a research officer in the German State Forests,

1939–1945, and worked in Finland and Russia; we are given to understand that at this time he achieved the unusual distinction of escaping twice from the Russian army. Nevertheless, he later became a research worker at the University of Tashkent, Uzbekistan, 1946–1949, and then at Leningrad (now St Petersburg), 1949–1955. He returned to West Germany and became a Forestry Planning Officer from 1955–1958. After this he took up the post of Forest Adviser to the United Nations Economic Commission for Africa, and subsequently became Director of Forestry in Ethiopia, 1958–1963.

He came to South Africa in 1963 and was appointed to the Forest Research Institute as District Forest Officer in the Western Cape on 16th October of that year. Initially based at Saasveld, near George, he developed and implemented the first scientific sustainable timber utilisation programme based on conservation-orientated multiple land

use principles. The system he applied to the southern Cape forests is regarded as one of the best of its kind as applied to indigenous forest timber in the world (Von dem Bussche 1992). He later moved to the Forestry Research Institute in Pretoria, eventually becoming Chief Professional Officer for research and planning regarding indigenous forests. He conducted woodland surveys in northern Namibia and carried out ecological surveys of the Natal and Transvaal forests. He also produced a comprehensive report on nature conservation and forestry legislation in the former states (homelands) of southern Africa. He retired at the unusually advanced age of 75, on 31 March 1992. After he retired, he continued working without pay, to complete his reports on indigenous forests (Von Breitenbach 1990b). Reports on several forests, namely Mpesheni, Engeli, Woodbush, De Hoek, Wolkberg, Steilkop, New Agatha and Entabeni, were almost ready for press.

His contributions to the literature on the forest and tree flora of southern Africa and Ethiopia include 11 books, some of which ran to more than one edition in his lifetime, and numerous scientific and more popular papers (Figure 7). The more easily accessible of these are listed in the bibliography appended to this obituary. It is interesting to note that the Finnish forestry advisers in Namibia have reprinted his book on Eastern Caprivi trees (Von Breitenbach 1967).

In a series on tree names published in *Trees in South Africa* from 1972 to 1976 he took up the tree numbers devised by De Winter *et al.* (1966) and information from the



FIGURE 6.—Dr Friedrich von Breitenbach OMS, with his Order for Meritorious Service decoration. Photo: Martin Gibbs.

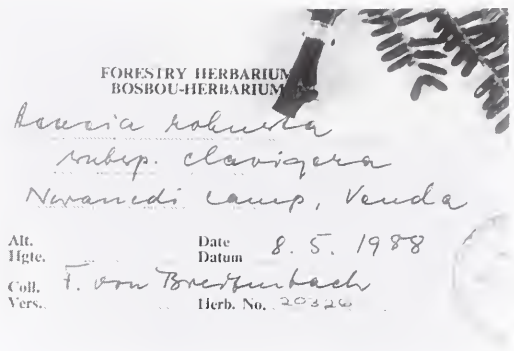


FIGURE 7.—Dr Von Breitenbach's handwriting, from a specimen in PRE. Photo: A. Romanowski.

first edition of *The National List of Trees/Die Nasionale Boomlys* by De Winter & Vahrmeijer (1972). He was joint author with De Winter and Vahrmeijer of the second edition of *The National Tree List* which appeared in 1978. The first edition of the 'green book': *National list of indigenous trees/Nasionale lys van inheemse bome* compiled by Dr von Breitenbach and published by the Dendrological Foundation appeared in November 1986. It was followed by a second impression in September 1987, a third impression in November 1988 and a second revised edition in January 1990. A third edition appeared in April 1995. A 'yellow book': *National list of introduced trees/Nasionale lys van ingevoerde bome*, in which about 1000 species are listed and supplied with numbers prefixed with an 'X', appeared in March 1984, to be followed by three further impressions and a second, revised edition which was published in 1989.

Dr von Breitenbach not only spread the word by publications, but also by giving lectures to various professional and amateur societies (Figure 8), as for example one to the Tree Society at their 26th Annual General Meeting (Meintjies 1973) on *Forests and trees of Ethiopia*. He also served as editorial consultant to several international and national scientific journals on botany and forestry. He kept close contact with dendrologists in many other countries and organized visits to southern Africa by members of the International Dendrological Society in 1988 and the Swiss Dendrological Society in 1992.

Fried and his wife Jutta were elected to the Tree Society committee at the 1980 Annual General Meeting (Katz 1980); Fried was elected to the post of vice chairman the next year (Higgs 1981), but was not mentioned at all in later accounts of this society's meetings. Dr Von Breitenbach was convinced that it was extremely important to involve the South African public in tree and nature conservation, and he spent an astonishing amount of energy and time to achieve this goal.

The Dendrological Foundation was established in Pretoria in 1979 with himself as chairman and one of the trustees. The objectives were the promotion, protection and preservation of trees and tree-dominated ecosystems by means of education and training, technical services, scientific research and publications. Membership was re-



FIGURE 8.—An English-language class of the Dendrological Society's Tree Knowledge Course at their first lecture session. Photo: J. von Breitenbach.

stricted to persons contributing financially or by voluntary work as researchers, lecturers, authors, editors etc. The board of trustees was constituted of eminent conservationists. The Dendrological Foundation was the parent organisation of the Dendrological Society of South Africa, which was founded in Pretoria in September 1980, with Dr von Breitenbach as first and only executive President and his wife as Honorary Secretary/Treasurer. This society attracted hundreds of members of the public over the years and claimed to be the fastest growing conservation body in South Africa. There are now almost 50 branches in various parts of the country, and even as far afield as Namibia. It concentrates on both one-day and weekend field excursions, and presents tree knowledge courses. The National Register of Big Trees was a product of this society, with Dr von Breitenbach as its keeper.

Dr and Mrs von Breitenbach produced *Dendron*, the newsletter of the Dendrological Society. This started out as the *Dendrological Foundation Newsletter/Nuusbrief Dendrologiese Stigting* in April 1979, and ran to 31 numbers until December 1993. It contained reports on branch activities and other news of interest not only to members of the society, but to everyone concerned with trees and nature conservation. Dr von Breitenbach was editor of the *Journal of Dendrology/Dendrologiese Tydskrif*, which he started in 1981. This occasional publication appeared in 13 numbers between then and 1991. Dr and Mrs von Breitenbach were not only the publishers of this journal; they wrote the majority of the articles. He took most of the photographs while she did the line drawings. He often wrote book reviews, and rarely short notes, under the

pseudonyms 'F.C. Brideswater' and 'F.K.M. von Westphalen'. The latter name is derived from his mother's (née Countess von Westphalen) maiden name. It seems that he used these pen-names for items which he considered to be of less scientific value than those to which he attached his own name. Several lists of common names of trees in black languages of South Africa appeared in the *Journal of Dendrology*. These lists are regarded as lists of standard names in the languages concerned.

He felt strongly that all aspects of nature conservation should be co-ordinated and so he was instrumental in the formation of the South African Nature Federation in 1987. The idea was to provide a framework in which all non-governmental organisations which are involved in conservation or related activities could co-operate. This Federation was to have held its first congress on 8 July 1995. He was interested in all inhabitants of forests, animals as well as plants, but tended to regard herbivores, even those naturally resident in the forest, as a threat to the trees.

'Dendroco', the South African Dendrogenetic Development Co-operative Ltd., with Dr von Breitenbach as its driving force and chairman, was established in March 1991. This registered primary agricultural co-operative is a self-financing development project which promotes the planting of indigenous trees by means of selective propagation and marketing of suitable cultivars for urban, agricultural and industrial use. The scheme involves a number of private tree breeders.

Dr von Breitenbach's most ambitious project in the line of publications was the *Tree atlas of southern Africa/Boomattas van Suider-Afrika*, the bilingual encyclopaedic opus on the $\pm$ 1000 indigenous trees of southern Africa, with himself and his wife as co-authors. Unfortunately only section I, covering the ferns and gymnosperms, has so far appeared. However, we are given to understand that production of the second volume is quite far advanced.

He collected relatively few (about 1000) specimens, mainly in the forests of the Western and Eastern Cape, and in Namaqualand, Caprivi and Ovambo/Kavango area (Namibia), and from cultivation; these were in SAAS and PRE, but were transferred to PRE in 1992/1993. He also collected specimens in Ethiopia; these are housed in Addis Ababa.

He was married to Jutta (née Hofrichter) on 17 June 1961. She became his lifelong companion and co-worker; many of his publications are illustrated with her line drawings. They had no children.

In recognition of Dr von Breitenbach's contributions to forestry, dendrology and environmental conservation, he was awarded the Order for Meritorious Service on 24 November 1992 by the State President.

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 Makena, M.S. Driver/Operator
 Makena, S.N. General Foreman
 Makena, T.J. Groundsman I
 Makgopo, C.K. Groundsman I
 Makhubela, D. General Foreman
 Makhubela, K.P. Groundsman I
 Makoeng, P.T. Groundsman I
 Makola, J. Groundsman I
 Makola, L.M. Groundsman II. Tractor driver
 Makua, E.G. Groundsman I
 Malewa, D. Groundsman I
 Malobola, L. Groundsman I
 Malobola, M. Groundsman II
 Maluleke, M.J. Security
 Mamietja, A. Groundsman I
 Mariri, N.J. Factotum
 Marule, P.M. Groundsman II. Tractor driver
 Masango, M.G. Groundsman I
 Mathabathe, D.S. Groundsman I
 Matlala, S.M. Groundsman I
 Matshika, S.P. Groundsman I

Mdluli, S. Artisan
 Mmakujwana, K.J. Groundsman I
 Mnyangeni, L.D. Groundsman I
 Modisha, D.M. Groundsman I
 Mogoru, M.F. Groundsman I
 Mogoru, S. Groundsman I
 Mohale, F.R. General Foreman
 Mohale, J.N. Groundsman I
 Mokawe, N.R. Groundsman I
 Molefe, J.R. Groundsman II
 Molokomme, J. Groundsman I
 Molomo, S.E. Groundsman I
 Mononyane, J.B. Groundsman I
 Motshweni, V.V. Groundsman I
 Mudau, R.T. Groundsman I
 Muhali, B. Groundsman I
 Nkambule, J. Groundsman I
 Nkoane, J.M. Groundsman I
 Nkwana, F.N. Driver/Operator
 Noko, J.M. Research Assistant
 Noku, A.Y. Groundsman II. Tractor driver
 Ramakgaphola, A.M. Groundsman I
 Ramatsetse, P.M. Security Assistant
 Rampopana, A.M. Groundsman I
 Sete, L. General Foreman
 Shirindi, J.R. Groundsman I
 Shirindi, S.M. Groundsman I
 Shilubane, E. Storeman Assistant
 Sithole, J. Groundsman I
 Schnackenberg, Ms H. Senior Provisioning Administra-
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 horticultural curation of living collections; garden
 development; seedbank of endangered plants and
 succulents; Madagascan plants
 Tefu, P.R. Groundsman I
 Tloubatla, J.L. Groundsman I
 Tolo, P.K. Groundsman I

WITWATERSRAND NBG—WILROPARK

Chaplin, P.J. N.T.C.Dip.(Hort.). Chief Research Technician

Bongwe, N.W. Groundsman I. Machine operator
 Hankey, A.J. N.D.(Hort.). Senior Research Technician
 Head, Mrs S.E. Senior Administration Clerk
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 Lukhwa, N.A. Groundsman I. Garden
 Luvhimbi, T.S. Groundsman I. Garden
 Majamane, Z.E. Groundsman I. Garden
 Mamosebo, M.A. Groundsman I. Garden
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 Manyikana, T.M. Groundsman I. Garden
 Matsea, M.W. Groundsman I. Garden
 Mbulaheni, N.P. Groundsman I. Garden
 Mulibana, N.S. Groundsman I. Machine operator
 Mmola, Ms B.E. Groundswoman I. Cleaner
 Ndou, A.P. Groundsman I. Garden
 Ndou, M.W. Groundsman I. Machine operator
 Ndwambi, N.W. Groundsman I. Garden

Nedambale, M.P. Groundsman II. Nursery
 Nematili, M.E. Driver
 Nematili, A.S. Groundsman II. Driver
 Nekhavhambe, S.P. Groundsman I. Garden
 Nenungwi, M.S. Groundsman I. Nursery
 Ngwenya, H.T. Groundsman I. Garden
 Rammela, N.N. Groundsman I. Machine operator
 Randima, M. Groundsman I. Garden
 Raphalalani, V.S. Groundsman I. Nursery
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 Van der Westhuizen, Mrs S. M.Sc. Environmental Educationalist

RESEARCH DIRECTORATE

PRETORIA

Director: Research—Vacant

Personal Secretary—Vacant

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PLANT SYSTEMATICS SUBDIRECTORATE

PRETORIA

Smith, G.F. Ph.D., F.L.S. Deputy Director. Systematics of succulents and rosulate, petaloid monocots
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 Koekemoer, Miss M. Curator: National Herbarium (Pretoria)
 Oliver, E.G.H. Curator: Stellenbosch Herbarium
 Potgieter, Mrs E. B.Bibl. Senior Librarian
 Rourke, Dr J.P. Curator: Compton Herbarium (Cape Town)
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DATA MANAGEMENT—PRETORIA

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Rourke, J.P. Ph.D., F.L.S. Specialist Scientist. Systematics of southern African Proteaceae, Stilbaceae

Cupido, Mrs C. Administration Aid
 Foster, Mrs S.E. Principal Typist
 Holm, Mrs K. Scientific Assistant
 Kurzweil, H. Ph.D. Scientist. Systematics of southern African terrestrial orchids
 Manning, J.C. Ph.D. Specialist Scientist. Systematics of Iridaceae and Orchidaceae; anatomy

Paterson-Jones, Mrs D.A. (née Snijman). Ph.D. Principal Scientist. Systematics of Amaryllidaceae; cladistics
 Roux, J.P. N.T.C.(Hort.), F.L.S., M.Sc. Principal Scientist. Systematics of Pteridophyta
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NATIONAL HERBARIUM—PRETORIA

Koekemoer, Miss M. M.Sc. Curator. Assistant Director. Taxonomy of Poaceae, Asteraceae; *Disparago* and related genera

Germishuizen, G. M.Sc. Principal Scientist. Assistant Curator: Finances, Plant identifications, taxonomy of Polygonaceae, Fabaceae, Loranthaceae, Viscaceae
 Herman, P.P.J. M.Sc. Principal Scientist. Assistant Curator: Personnel. Taxonomy of Asteraceae, Flora of Transvaal
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 Meyer, Mrs N.L. B.Sc.(Hons). Senior Scientific Officer. Assistant Curator: Public relations
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 Anderson, J.M. Ph.D. Specialist Scientist. Palaeobotany, palaeogeography
 Archer, R.H. M.Sc. Senior Scientific Officer. Taxonomy of mainly Celastraceae, Euphorbiaceae
 Archer (née Reid) Mrs C. M.Sc. Senior Scientist. Taxonomy of Cyperaceae, Restionaceae, Orchidaceae
 Bredenkamp, Mrs C.L. M.Sc. Chief Scientific Officer. Taxonomy of *Vitex*, Rhamnaceae, Sterculiaceae and other related families
 Burgoyne, Ms P.M. B.Sc.(Hons). Senior Specialized Auxiliary Services Officer
 Cloete, Mrs M. Dip.(Typing). Senior Provisioning Clerk
 Dreyer, Miss L.L. M.Sc. Senior Scientific Officer. Taxonomy of Geraniaceae, Crassulaceae, Oxalidaceae
 Fish, Mrs L. B.Sc. Chief Scientific Officer. Taxonomy of Poaceae; plant collecting programme
 Glen, H.F. Ph.D. Senior Scientist. Taxonomy of trees and succulents, especially *Aloe*, also cultivated plants
 Glen, Mrs R.P. M.Sc. Senior Scientific Officer. Taxonomy of ferns, water plants
 Hartzer, Mrs P.C.M.H. M.Sc. Principal Scientific Officer. Taxonomy of Mesembryanthemaceae
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 Meyer, J.J. N.D.(Teaching). Specialized Auxiliary Services Officer
 Perold, Mrs S.M. Ph.D. Taxonomy of Ricciaceae, Hepaticae
 Phahla, T.J. Specialized Auxiliary Services Officer. Mounting herbarium specimens
 Ready (née Taussig), Mrs J.A. N.D.(Hort.). Senior Specialized Auxiliary Services Officer. Taxonomy of *Striga*
 Retief, Miss E. M.Sc. Senior Scientist. Pollen studies of Boraginaceae. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Asteraceae, Rubiaceae
 Smithies, Mrs S.J. M.Sc. Senior Scientific Officer. Taxonomy of mainly Scrophulariaceae, Selaginaceae, Lobeliaceae
 Van Rooy, J. M.Sc. Senior Scientist. Taxonomy and biogeography of mosses
 Veldman, Mrs J.M. Senior Provisioning Clerk
 Victor, Ms J.E. B.Sc.(Hons.), H.Dip.Journ. Scientific Officer. Taxonomy of Proteaceae, Bruniaceae, Rosaceae, Rutaceae
 Welman, Miss W.G. M.Sc. Senior Scientist. Taxonomy of Convolvulaceae, Solanaceae, Cucurbitaceae, Campanulaceae, Asteraceae, Acanthaceae

STELLENBOSCH HERBARIUM

Oliver, E.G.H. M.Sc. Curator. Scientist. Taxonomy of the Ericoideae (Ericaceae)

Beyers, Mrs J.B.P. M.Sc. Scientist. Taxonomy of the
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Davidse, Mrs E. Scientific Assistant

Fellingham, Mrs A.C. B.Sc. Scientific Officer. Taxonomy
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Leith, Mrs J. Administration Clerk

RESEARCH SUPPORT SERVICES—PRETORIA

Du Plessis, Mrs H. M.Sc. Head of Cost Centre. Scientist. Cytogenetics

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Condy, Ms G.S. M.A. Botanical artist
Romanowski, Mrs A.J. Dip.(Photography). Industrial
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Steyn, Miss C.C. Scientific Assistant. Anatomy, palynol-
ogy
Steyn, Mrs E.M.A. Ph.D. Senior Scientist. Embryology
Thiart, Mrs S.M. Dip.(Typing). Principal Typist

ECOLOGY SUBDIRECTORATE

CAPE TOWN

Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director

Davis, G.W. Ph.D. Programme Leader Stress Ecology
Donaldson, J.S. M.Sc.(Entomology), Ph.D.(Zoology). Programme Leader. Conservation Biology
Fritz, M.F. Scientific Assistant
Hunter, Ms D.A. Administrative Secretary
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Powrie, L.W. M.Sc. Scientific Officer. Ecological databases: computer co-ordination
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STRESS ECOLOGY—CAPE TOWN

Davis, W.W. Ph.D. Programme Leader. Stress and disturbance ecology

De Witt, D.M. Scientific Assistant
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Jagger, B.W. Scientific Assistant
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Musil, C.F. Ph.D. Scientist. Plant stress physiology/ecol-
ogy
Snyders, S.G. Scientific Assistant
Wand, S.J.E. M.Sc.(Agric.). Scientist. Plant stress physiology/
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Bösenberg, J. de W. B.Sc.(Hons). Scientific Officer
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Bowler, Mrs M. Laboratory & Office Aid
Brown, N.A.C. Ph.D. Specialist Scientist. Seed biology
research, plant growth regulators
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Ecology, tissue culture, horticulture
Hilton-Taylor, C. B.Sc.(Hons)(Biological Sci.). Assistant
Scientist. Threatened plants, biodiversity of arid

regions
McDonald, D.J. M.Sc. Senior Scientist. Mountain vegeta-
tion, biogeography, conservation
Nänni, Ms I. B.Sc., H.E.D. Scientific Officer. Ecology,
conservation biology
Parenzee, Ms H.A. Administrative Assistant
Rebello, A.G. Ph.D.(Zoology). Scientist. Conservation bi-
ology, biogeography
Scott, Mrs G. B.Sc.(Pharmacy), M.Sc. Scientific Offi-
cer. Plant secondary compounds, medicinal plants

HARRY MOLTENO LIBRARY—CAPE TOWN

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PUBLICATIONS BY THE STAFF

(1st April 1994—31st March 1995)

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- COWAN, A.K., TURNER, S.L. & BOTHA, C.E.J. 1995. Effect of water stress and diclofop-methyl on photosynthesis, carotenoid and abscisic acid content of leaves of *Avena byzantina* and *Avena fatua*. *South African Journal of Botany* 61: 29–34.
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- CROUCH, N.R. 1994a. The weedy ferns of Ferneliffe. Unusual invaders threaten Natal's flora. *Veld & Flora* 80: 88–90.
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- CROUCH, N.R., McDONALD, G., NGWENYA, A., NICHOLS, G., SIKHAKANE, B. & SINGH, Y. 1994. *Zeuxine africana*: Durban's odd-ball orchid. *South African Orchid Journal* 25: 127–129.
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- DAVIS, G.W. 1994c. Contemporary land use conflicts: adjusting to reconstructive policy options for a democratic South Africa (Summary of conference paper). *Noticiero de Biología* 2: 20.
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- DAVIS, G.W. 1994g. Kickstarting global change research in southern Africa: a report of the first Southern, Central and Eastern African (SAF) regional workshop of the Global Change SysTem for Analysis Research and Training (START), Gaborone, Botswana, July 4–7, 1994. *Bulletin of the Southern African Institute of Ecologists & Environmental Scientists* 13,2: 17–20.
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- DONALDSON, J.S. & SCOTT, G. 1994. Aspects of human dependence on plant diversity in the Cape mediterranean-type ecosystem. *South African Journal of Science* 90: 338–342.
- DRY, D.H. 1994a. Preliminary report on the growth rate of indigenous tree species at the Pretoria National Botanical Garden. *Parks and Grounds* 80: 53, 54.
- DRY, D.H. 1994b. Jams...and jellies. *South African Garden Guide*: 4: 24, 25.
- DRY, D.H. 1994c. The myrrh of the Bible. *The South African nurseryman* 13,2: 15, 16.
- DUNCAN, G.D. 1994. The genus *Lachenalia*, and the discovery of a beautiful new species from the Western Cape Province of South Africa. *Shin-Kaki* 163: 32–35.
- FELLINGHAM, A.C. 1994. *Cliffortia longifolia*, a 'good' species or should it be a variety under *C. strobilifera*? (Rosaceae). *Bothalia* 24: 31–34.
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- GERMISHUIZEN, G., LEISTNER, O.A., MARCH, H. & SCOTT, M., 1994. *Erianthemum dregei* (Loranthaceae). *Flowering Plants of Africa* 53: 16–19, t. 2084.
- GERMISHUIZEN, G., LEISTNER, O.A. & SCOTT, M. 1994a. *Vanwykia remota* (Loranthaceae). *Flowering Plants of Africa* 53: 2–5, t. 2081.
- GERMISHUIZEN, G., LEISTNER, O.A. & SCOTT, M. 1994b. *Pedistylis galpinii* (Loranthaceae). *Flowering Plants of Africa* 53: 6–9, t. 2082.
- GERMISHUIZEN, G., LEISTNER, O.A. & SCOTT, M. 1994c. *Tapianthus terminaliae* (Loranthaceae). *Flowering Plants of Africa* 53: 20–24, t. 2085.
- GERMISHUIZEN, G. & SCOTT, M. 1994. *Moquiniella rubra* (Loranthaceae). *Flowering Plants of Africa* 53: 10–14, t. 2083.
- GLEN, H.F., LAVRANOS, J.J. & CONDY, G. 1994. *Crinum balfourii* (Amaryllidaceae). *Flowering Plants of Africa* 53: 64–68, t. 2093.
- GLEN, H.F. & SMITH, S. 1994. A larin in the First National Bank Museum. *Journal of the Association of Numismatic Societies of South Africa* 4: 6, 7.
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- HILTON-TAYLOR, C. & SMITH, G.F. 1994. The conservation status of Alacoeae in southern Africa. In B.J. Huntley, Botanical diversity in southern Africa, Parts 1 & 2. *Strelitzia* 1: 287–303.
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- HOFFMAN, M.T., KERLEY, G.I.H., MILTON, S.J. & DEAN, W.R.J. 1994. Desertification in developed countries. *Bulletin of the Southern African Institute of Ecologists & Environmental Scientists* 13,3: 15, 16.
- HOFFMAN, M.T., MIDGLEY, G.F. & COWLING, R.M. 1994. Plant richness is negatively related to energy availability in semi-arid southern Africa. *Biodiversity Letters* 2: 35–38.
- HUNTLEY, B.J. (ed.) 1994a. Botanical diversity in southern Africa, Parts 1 & 2. *Strelitzia* 1. National Botanical Institute, Pretoria.
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Guide for authors to Bothalia

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

1 Editorial policy

1.1 *Bothalia* welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews, are accepted. Manuscripts may be written in either English or Afrikaans.

1.2 **Page charges:** As stated in our notification included in volume 23,1 (May 1993), MSS submitted for publication in *Bothalia* after the 10th June 1993 are subject to payment of page charges of R125,00 per printed page, VAT included. The following are exempt from these charges: 1, NBI members; 2, persons/institutions who have been granted exemption by the Executive Committee of the NBI; 3, authors of contributions requested by the Editor. The Editor's decision on the number of pages is final. An invoice will be sent to the author, who must arrange for payment as soon as possible to NBI, publications section, Private Bag X101, Pretoria 0001.

1.3 Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

Hard copy of articles should preferably be accompanied by PC diskettes or stiffies.

2 Requirements for diskettes/stiffies

2.1 data must be IBM compatible and written in **ASCII, or in Word for Windows from Windows 1; Word for MS-DOS from MSWord 3; Word for Macintosh from Macintosh 4; WordPerfect 5 onwards; Windows Write 3 onwards.**

2.2 the original printout of the diskette should be supplied in double line spacing.

2.3 **tables need not be placed on the diskette—a clearly laid out hard copy is adequate.**

2.4 **use a non-breaking space to keep two elements together on the same line e.g. 3 500.**

2.5 do not justify lines.

2.6 do not break words, except hyphenated words.

2.7 all lines, headings, keys, etc., should start flush at the margin, therefore no indentations of any kind.

2.8 **italics and bold should be used where necessary.**

2.9 **paragraphs and headings are delineated by a carriage return (ENTER) but no indentation.**

2.10 a hyphen is designated as one dash, with no space between the letter and the dash, e.g. ovate-lanceolate. See also 17.6.

2.11 an N-dash is typed as **three** hyphens with no space between the letter and the hyphen, e.g. 2 - - 5 mm (typeset, it looks like this, 2–5 mm).

2.12 an M-dash is typed as **two** hyphens with no space between the letter and the hyphen, e.g. computers -- what a blessing! (typeset, it looks like this, computers—what).

2.13 do not use a double space between words, after commas, full stops, colons, semicolons or exclamation marks.

2.14 use lower case x as times sign, with one space on either side of the x, e.g. 2 x 3 mm.

2.15 use **single (not double)** opening and closing quotes, e.g. the so-called 'stiffy' refers to a rigid diskette.

2.16 keys—put only three leader dots before number and name of taxon (with one space before and one space after the first and last dot), regardless of how far or near the word is from the right margin, e.g. ... 1. R. ovata (see 13.18).

3 Requirements for a manuscript

3.1 The original manuscript should be typewritten on one side of good quality A4-size paper, double-spaced throughout (including abstract, tables, captions to figures, literature references, etc.) and have a margin of at least 30 mm all round. **Three** photocopies (preferably **photocopied on both sides** of the paper to reduce weight for postage) of all items, including text, illustrations, tables and lists should be submitted, and the author should retain a complete set of copies.

3.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 17 onwards).

3.3 Material should be presented in the following sequence: Title page with title, name(s) of author(s), keywords, abstracts (in English and Afrikaans) and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies.

3.4 The sequence continues with Introduction and aims, Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes and book reviews, keywords and abstract are superfluous.

3.5 All pages must be numbered consecutively beginning with the title page to those with references, tables and captions to figures.

3.6 For notes on the use of hyphens and dashes see 2.10 to 2.12.

3.7 **Special character: use your own word or code that is unique and self-explanatory, enclosed between ANGLE BRACKETS, e.g. <mu>m for µm. Please supply us with a list of the codes.**

4 Author(s)

When there are several authors the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address and telephone number should be mentioned if they differ from those given on the letterhead.

5 Title

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but author citations should be omitted from plant names.

6 Keywords

Up to 10 keywords (or index terms) should be provided in English in **alphabetical sequence**. The following points should be borne in mind when selecting keywords:

6.1 keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 they should be in a noun form and verbs should be avoided.

6.3 they should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 they should not contain prepositions.

6.5 the singular form should be used for processes and properties, e.g. evaporation.

6.6 the plural form should be used for physical objects, e.g. augers.

6.7 location (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 they should include terms used in the title.

6.10 they should answer the following questions:

6.10.1 what is the *active concept* in the document (activity, operation or process).

6.10.2, what is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3, what is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 what is the environment in which the active concept takes place (medium, location).

6.10.5 what are the independent (controlled) and dependent variables?

6.11 questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

7 Abstract

7.1 Abstracts of no more than 200 words should be provided in English and Afrikaans. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article. ^

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations.

7.4 Names of new taxa and new combinations should not be underlined. If the article deals with too many taxa only the important ones should be mentioned.

8 Table of contents

A table of contents should be given for all articles longer than about 15 typed pages, unless they follow the strict format of a taxonomic revision.

9 Acknowledgements

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

10 Literature references

In text

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When **more than two authors** are involved in the paper use the name of the first author followed by *et al.*

10.3 When referring to more than one literature reference, they should be arranged **chronologically** and separated by a semicolon, e.g. (Nixon 1940; Davis 1976; Anon. 1981, 1984).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 & 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full

initials to identify the person more positively, e.g. C. Boucher pers. comm.

In References at end of article

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference, **except in an obituary, where the name of the deceased in the list of publications (not in the references) is replaced by an N dash.**

10.8 All publications referred to in the text, **including those mentioned in full in the treatment of correct names in taxonomic papers**, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year.

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in capitals.

10.12 Titles of journals and of books are written out in full and are underlined as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 If the same author is mentioned more than once, the name is written out in full and not replaced by a line.

10.15 Examples of references:

Collective book or Flora

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6,2: 518–1036. Reeve, London.
CUNNINGHAM, A.B. 1994. Combining skills: participatory approaches in biodiversity conservation. In B.J. Huntley, *Botanical diversity in southern Africa. Strelitzia* 1: 149–167. National Botanical Institute, Pretoria.

Book

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11 Tables

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'table' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

12 Figures

12.1 Figures should be planned to fit, after reduction, into a **width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.**

12.2 Line drawings, including graphs and diagrams, should be in jet-black Indian ink, preferably on fine Felix Schoeller parole or similar board, 200 gsm, or tracing film. Lines should be bold enough **and letters/symbols large enough** to stand reduction.

12.3 It is recommended that drawings should be twice the size of the final reproduction.

12.4 Photographs should be of excellent quality on glossy paper with clear detail and moderate contrast, and they should be the same size as required in the journal.

12.5 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white **flexible card base (can be curved around drum of scanner)** base leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions.

12.6 Lettering and numbering on all figures should be done in leterset, stencilling or a comparable method. If symbols are to be placed on a dark background it is recommended that black symbols are used on a small white disk ± 7 mm in diameter and placed in the **lower left hand corner** of the relevant photo.

12.7 If several illustrations are treated as components of a single composite figure they should be designated by **capital letters**.

12.8 Note that the word 'Figure' should be written out in full, both in the text and the captions and should begin with a capital 'F' (**but see 14.7 for taxonomic papers**).

12.9 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B, C) are...'

12.10 In captions, 'figure' is written in capital letters. Magnification of figures should be given for the size as submitted.

12.11 **Scale bars or scale lines should be used on figures.**

12.12 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.13 Figures are numbered consecutively with Arabic numerals **in the order they are referred to in the text**. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.14 Captions of figures must **not** be pasted under the photograph or drawing.

12.15 Authors should indicate **in pencil** in the text where they would like the figures to appear.

12.16 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.17 Authors wishing to use illustrations already published must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.18 Captions for figures should be collected together and typed on a **separate sheet** headed *Captions for figures*.

12.19 It is strongly recommended that taxonomic articles include dot maps, as figures, to show the distribution of taxa. The dots used must be large enough to stand reduction to 80 mm (recommended size: leterset 5 mm diameter). **No open diamonds or open triangles should be used.**

12.20 **Blank distribution maps of southern Africa, Africa and the world are available from the bookshop, NBI Pretoria.**

13 Text

13.1 As a rule, authors should use the plant names (**but not of all authors of plant names—see 13.6**) as listed by T.H. Arnold & B.C. de Wet (eds) in *Memoirs of the Botanical Survey of South Africa* No. 62.

13.2 Names of genera and infrageneric taxa are usually underlined, with the author citation (where relevant) not underlined. Exceptions include names of new taxa in the abstract, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles; in checklists and in indices, where the position is reversed, correct names are not underlined and synonyms are underlined.

13.3 Names above generic level are not underlined.

13.4 In articles dealing with taxonomy and closely related subjects the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion (see 16.6).

13.5 In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom. nud.* *et al.* are not italicized (see 16.4).

13.6 **Names of authors of plant names should agree with the list published by the Royal Botanic Gardens, Kew, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).**

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are underlined whenever they are linked to the number of a specimen. The collection number is also underlined, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capital letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). **In taxonomic papers only mm and m, should be used; in ecological papers cm or m should be used.**

13.12 The use of '±' is preferred to c. or ca (see 17.7).

13.13 Numbers 'one' to 'nine' are spelled out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5). When counting members write 2 or 3 (not 2–3) but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.), after units of measure, after compass directions and after herbarium designations.

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on an elongated stem; a submerged aquatic with only the capitula exserted ... 1b. *E. setaceum* var. *pumilum*

1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:

2a Annuals, small, fast-growing pioneers, dying when the habitat dries up; capitula without coarse white setae; receptacles cylindrical:

3a Anthers white ... 2. *E. cinereum*

3b Anthers black ... 3. *E. nigrum*

2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

14 Species treatment in taxonomic papers

14.1 The procedure to be followed is illustrated in the example (17.9), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (not underlined) is to be followed by its author citation (underlined) and the full literature reference, with the name of the publication written out in full (not underlined).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E. Hubb. in Kew Bulletin 15: 307 (1960); Boris *et al.*: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time*, *diagnostic characters*, *distribution* and *habitat*.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop, the first line of the paragraph to be indented. Intraspecific taxa are marked with small letters, e.g. 1b., 12c., etc.

14.6 Names of authors are written as in 13.6, irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet' (but see 12.8 for normal text).

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word *Icones* followed by a colon. This paragraph is given after the last paragraph of the synonymy, see 17.9.

15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant, e.g. Port Natal [now Durban]), **quarter-degree square**, date of collection (optional), collector's name and collecting number (both underlined).

15.2 The abbreviation *s.n.* (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question. The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum*.

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon.* 422 (X, holo.–BOL, photo.!).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen, this should be indicated by using the phrase 'here designated' (see 17.9). If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning only a few species and a few cited specimens the specimens should be arranged according to the grid reference system: Provinces/ countries (typed in capitals) should be cited in the following order: Namibia, Botswana, **Northern Province** (previously Northern Transvaal), **North-West**, **Gauteng** (previously PWV), **Eastern Transvaal**, **Free State** (previously Orange Free State), Swaziland, **KwaZulu-Natal**, Lesotho, and **Northern Cape**, **Western Cape** and **Eastern Cape** (see Figure 1, p. 283).

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e. (–AC) precedes (–AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

KWAZULU-NATAL.—2731 (Louwsburg): 16 km E of Nongoma, (–DD), *Pelser* 354 (BM, K, PRE); near Dwaarsrand, *Van der Merwe* 4789 (BOL, M). 2829 (Harrismith): near Groothoek, (–AB), *Smith* 234; Koffiefontein, (–AB), *Taylor* 720 (PRE); Cathedral Peak Forest Station, (–CC),

Marriot 74 (KMG); Wilgerfontein, Roux 426. Grid ref. unknown: Sterkstroom, Strydom 12 (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, Napier 485.

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both underlined). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a **comma**. The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the latest edition of *Index Herbariorum*. They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *T.H. Arnold* 64 (PRE); *Fisher* 840 (NH, NU, PRE); *Flanagan* 831 (GRA, PRE), 840 (NH, PRE); *Marloth* 4926 (PRE, STE); *Schelpé* 6161, 6163, 6405 (BOL); *Schlechter* 4451 (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they must be listed together before Acknowledgements under the heading *Specimens examined*. They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infraspecific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are underlined:

Acocks 12497 (2.1b) BM, K, PRE; 14724 (1.13a) BOL, K, P. *Archer* 1507 (1.4) BM, G. *Burchell* 2847 (2.8c) MB, K. *Burman* 2401 (3.3) MO, S. *B.L. Burtt* 789 (2.6) B, KMG, STE.

16 Synonyms

16.1 In a monograph or a revision covering all of southern Africa, all synonyms based on types of southern African origin, or used in southern African literature, should be included.

16.2 Illegitimate names are designated by *nom. illeg.* after the reference, followed by *non* with the author and date, if there is an earlier homonym.

16.3 *Nomina nuda* (*nom. nud.*) and invalidly published names are excluded unless there is a special reason to cite them, for example if they have been used in prominent publications.

16.4 In normal text Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud.* are not italicized (see 13.5).

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial, except where intervening references to other genera with the same initial could cause confusion (see 13.4).

17 Description and example of species treatment

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches*. *Bark*. *Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/below, texture, colour; petiole: stipules. *Inflorescence*: type, shape, position; bracts/bracteoles. *Flowers*: shape, sex. *Receptacle*. *Calyx*. *Corolla*. *Disc*. *Androecium*. *Gynoecium*. *Fruit*. *Seeds*. *Chromosome number*. Figure (word written out in full) number.

17.2 As a rule, shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens. A *hyphen* is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke. An *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'); it is produced by typing **three** hyphens next to each other. An *M-dash* (*em*) is a stroke longer than an N-dash and is used variously, e.g. in front of a subspecific epithet instead of the full species name; it is produced by typing **two** hyphens next to one another.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements, dimensions, etc. (see 13.12).

17.8 The decimal point replaces the comma in all units of measurement, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. *Bequaertiodendron magalismontanum* (Sond.) Heine & Hemsl. in Kew Bulletin: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980). Type: *Gauteng*, Magaliesberg, *Zeyher* 1849 (S, holo.–BOL, photo.).

Chrysophyllum magalismontanum Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: (1973).

Chrysophyllum argyrophyllum Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin: 98 (1973). Types: Angola, *Welwitsch* 4828 (BM!; lecto., here designated; PRE!); Angola, *Welwitsch* 4872 (BM!).

Chrysophyllum wilmsii Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: **Eastern Transvaal**, Magoebaskloof, *Wilms 1812* (B, holo.; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!).

Bequaertiodendron fruticosa De Wild.: 37 (1923), non Bonpl.: 590 (1823); D. Bakker: 167 (1929); H. Fr.: 302 (1938); Davy: 640 (1954); Breytenbach: 117 (1959); Clausen: 720 (1968); Palmer: 34 (1969). Type: **Eastern Transvaal**, Tzaneen Dist., *Granville 3665* (K, holo.; G!, P!, PRE!, S!).

B. fragrans auct. non Oldemann; Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapelton: 6 (1954).

Icones: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves* linear to oblanceolate, 3–10(–23) $\pm$ 1.0–1.5(–4.0) mm, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 $\pm$ 5 mm, solitary, sessile at tip of axillary shoots; involucre bracts in 5 or 6 series, inner exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* $\pm$ 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* $\pm$ 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. *Chromosome number*: $2n = 22$. Figure 23B.

18 New taxa

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration (line drawing or photograph) and a distribution map.

18.3 Example:

109. *Helichrysum jubilatum* Hilliard, sp. nov. *H. alsinoides* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditorum aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 $\pm$ 5–15 mm, sub capitulis minora, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato-arachnoidea. *Capitula* heterogama, campanulata, 3.5–4.0 $\pm$ 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solitaria vel 2–3 ad apices ramulorum nudorum ad 30 mm longorum. *Bractae involucreales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* $\pm$ 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

TYPE.—**Northern Cape**, 2817 (Vioolsdrif): Richtersveld, (–CC), $\pm$ 5 miles E of Lekkering on road to Stink-

fontein, kloof in hill south of road, annual, disc whitish, 7–11-1962, *Nordenstam 1823* (S, holo.; E, NH, PRE).

19 New provinces of South Africa (Oct. 1995)

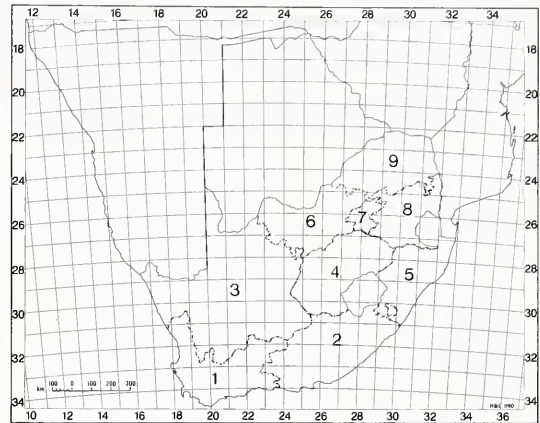


FIGURE 1.—1, Western Cape; 2, Eastern Cape; 3, Northern Cape; 4, Free State (previously Orange Free State); 5, KwaZulu-Natal; 6, North-West (previously northeastern Cape and southwestern Transvaal); 7, Gauteng (previously PWV); 8, Eastern Transvaal; 9, Northern Province (previously Northern Transvaal).

20 Proofs

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor as soon as possible.

21 Reprints

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

22 Documents consulted

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanical Garden*, *Botanical Journal of the Linnean Society*, *Flora of Australia*, *Smithsonian Contributions to Botany*, *South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science*.

23 Address of editor

Manuscripts should be submitted to: The Editor, Bothalia, National Botanical Institute, Private Bag X101, Pretoria 0001.

24 FSA contributions

24.1 Figures and text must conform to *Bothalia* format.

24.2 These articles will be considered as a full contribution to the *Flora of southern Africa* and will be listed as published in the 'Plan of *Flora of southern Africa*', which appears in all issues of the FSA series.

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